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SUSAN M. COLBERG

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Department of Art and Design
University of Alberta

Susan Colberg

Graphic presentation of language for dyslexic children:

typographic design to facilitate beginning reading

Visual Communication Design
Master's Thesis Project

Department of Art and Design
University of Alberta

Abstract

Visual Communication Design
Master's Thesis Project
Susan Colberg

A system of of graphic and typographic linguistic cues that render visible the patterns of graphic language was developed to explore the possibility of simplifying the learning of pre-reading and beginning reading skills, through the graphic presentation of language, for children who show early signs of specific reading disability–dyslexia.

Children who suffer from what appears to be a limited facility in using language to code other types of information find it extremely difficult to interpret and integrate letter symbols, to translate those letter symbols into sounds, and to comprehend sound relationships and meaning in them.

The instructional materials developed were designed to simplify the acquisition of reading skills by helping these children learn to decode, recall and understand aural and linguistic information. The motivational power, operational or functional facility and flexibility and adaptability of the instructional materials, to a wide variety of remedial, prescriptive and typical instructional tasks and objectives, were evaluated in three distinct instructional situations.

Based on the research undertaken, the product developed and the user response during the initial evaluation process, some recommendations are made regarding the potential of the proposed materials and implications for further investigation are discussed.

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Master's Thesis Project

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University of Alberta

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Introduction

Visual communication designers, with the help of professionals in other disciplines, can make valuable contributions to society by developing methods and products that may aid in the perception, discrimination, selection and use of visual information (whether pictorial, symbolic or linguistic in nature) by addressing the visual, scientific and technical aspects of society's communication requirements. The field of visual communication design is concerned with the ways in which society's communications are received, how they are perceived and whether or not they are understood and acted upon. The visual presentation of verbal information (the design of reading material) is central to the field.

The ability to read is critical to successful communication. It is required to solve the practical problems of daily life essential to the growth, health, well-being and often *survival* of an individual— in order to comprehend road signs, warning labels, telephone books, maps, forms, newspapers, reference manuals and books.

Reading involves the neuropsychological (perceptual-linguistic) process of making discriminative responses to graphic language. The purpose of reading, a complex form of symbolic learning, is to perceive, analyze, decode, attribute meaning *to* and comprehend meaning *in* graphic language. Reading concerns not only the content of the textual material, but also its typographic design and arrangement which contribute to the legibility and accessibility of the information contained in the text.

Beginning in early childhood, visual association and language experience are gradually refined. Visual and aural perception, discrimination and recall improve through experience so that novel perceptions can be organized and integrated. These skills are essential to the reading process.

Dyslexia is a severe learning disability that results in significant difficulties in reading. Although dyslexic children are of average or above average intelligence, this impairment *appears* to result in perceptual-linguistic distortions and the inability to translate letter symbols into sounds, to interpret and integrate these letter symbols and to comprehend sound relationships and meaning in them.

There are many cognitive abilities intrinsic to reading. Most are based on auditory and visual analysis, integration and decoding — these are some of the skills in which dyslexic children seem to be most deficient. The fact that graphic language seldom contains signals for pronunciation, inflection, stress and pause frustrates their efforts to read — these are all skills that *must* be learned.

Research has demonstrated that an appropriate instruction program (special education) during preschool and primary school years can contribute to improved language and reading abilities which may be critical for these children. The immediate educational need is for innovative and intensive

teaching with materials that will help improve language development and reading performance.

This thesis investigates the possibility of improving those beginning reading skills, in which dyslexic children appear to be weakest, through a system of typographic/linguistic cues. The cues are used in the design of an educational activity intended to consolidate those skills in order to facilitate beginning reading for dyslexic children. The research and product developed may also be useful for beginning readers who are not learning disabled and for other types of remedial reading situations.

The design development of this project is concerned with the aesthetic form and appearance of the product, with its function, communication, and with improving the relationships between the product/activity and the users/children.

Problem definition

1.0 Facilitation of beginning reading for dyslexic children

To provide background information and an initial frame of reference, within which the problem of facilitating beginning reading for dyslexic children can begin to be addressed, a definition of dyslexia, hypotheses about its origin and its relationship to information processing and memory are outlined below.

Definition of terms

Developmental Dyslexia

A learning disability that results in specific reading difficulty in an otherwise normal, intelligent child.

Learning Disability (LD)

The definition put forward by the US National Advisory Committee on Handicapped Children (1968) states that:

> Children with special learning disabilities exhibit a disorder in one or more of the basic psychological processes involved in understanding or in using spoken or written language. These may be manifested in disorders of listening, thinking, talking, reading, spelling, or arithmetic. They include conditions which have been referred to as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia, developmental aphasia, etc. They do *not* include problems which are due primarily to visual, hearing, or motor handicaps, to mental retardation, emotional disturbance, or to environmental disadvantage.

A more recent definition by Hammill, Leigh, McNutt and Larsen (1981) attempts to clarify the term "basic psychological processes" by pointing out that the lack of achievement is due to neurological dysfunction within the child:

> *Learning disabilities* is a generic term that refers to a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning, or mathematical abilities. These disorders are intrinsic to the individual and presumed to be due to central nervous system dysfunction. Even though a learning disability may occur concomitantly with other handicapping conditions (e.g., sensory impairment, mental retardation, social and emotional disturbance) or environmental influences (e.g., cultural differences, insufficient/inappropriate instruction, psychogenic factors), it is not the direct result of those conditions or influences.

Perception

Perception is the process of becoming aware of objects, qualities or relations through information received and coded by the sense organs. Sensory content is always present, but what is perceived is influenced by prior experience making perception an active process and not merely passive registration of stimuli impinging on the sense organs. Stimuli tend to be perceived and organized according to the perceptual principles of proximity, similarity, continuity and enclosure.

Hypotheses about the origin of dyslexia

Dyslexia is a term that essentially refers to extreme difficulty in learning to identify printed words. The problem is purported to originate in the visual-spatial system of perception. Letter reversal and mirror writing are often considered indicators of dyslexia as is uncertain hand-preference. Children who learn alphabetic rather than pictographic or ideographic writing are said to be more susceptible to the condition because of the abstract nature and lack of semantic relations in alphabetic symbols. Dyslexia is considered to be correctable by means of "strengthening" the visual-spatial system. According to recent research these and other popular perceptions are flawed.

It was in 1925, through Samuel Orton, that dyslexia was first seen as originating in the visual system. He suggested that the apparent dysfunction in visual perception and visual memory, characterized by the perception of letters and words reversed and transposed, was the cause of dyslexia. He further suggested that the disorder was caused by a lag in maturation — the failure of one hemisphere of the brain to dominate in the development of language. According to Vellutino (1987) this is still a viable hypothesis.

Other hypotheses which suggest that dyslexia may be caused by motor and visual defects or by problems with eye movements affecting binocular coordination, tracking and scanning ability, still provide the basis for many therapeutic approaches to the condition. Vellutino and his colleagues have begun to examine and challenge these beliefs about dyslexia including the notion that the condition originates in the visual system. With researchers in North America and abroad they have found dyslexia to be a subtle language deficiency having roots in other areas such as:

a *phonological coding*: an inability to represent and access the sound of a word in order to help remember it
b *deficient phonemic segmentation*: an inability to break words into component sounds
c *poor vocabulary development*: small, simple internal "lexicon"
d *poor analytical skills*: difficulty discriminating grammatical and syntactic differences among words and sentences

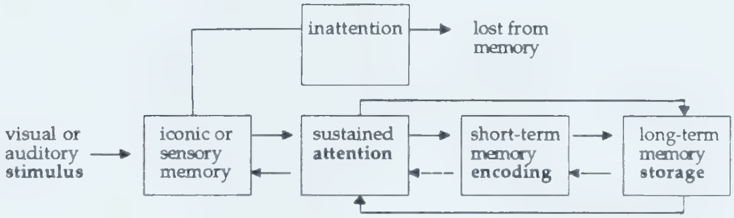
Their conclusion: that dyslexia seems to be the consequence of a limited facility in using language to code other types of information.

Dyslexia, information processing and memory

Recent studies seem to indicate that dyslexia is as closely related to the cross-referencing and retrieval of coded information already stored in memory as it is to the coding and storing of novel information.

Information processing for storage in memory proceeds in stages. The first stage takes place in *iconic memory* or the sensory storage system where a replica of the stimulus is held briefly. If the stimulus is attended to, it enters the second stage believed to take place in working or *short-term memory* — a system of limited capacity in which physical information is encoded or transformed into a more abstract, symbolic representation for storage in *long-term memory* which is thought to have unlimited capacity. In the final stages of memory processing the stimulus, in its encoded form, is:

a *categorized and stored* in long-term memory
b *discarded* or
c *lost* inadvertently from short-term memory



Information processing model
The long arrows suggest that attention to a familiar stimulus is more likely because a representation of it has been stored in long-term memory (based on Vellutino, 1987)

Vellutino and his colleagues believe that dyslexia is more "a symptom of dysfunction during storage and retrieval of linguistic information" than a consequence of defects in the visual-spatial system.

Some researchers suggest that some "poor readers" have trouble recalling visually presented information because the initial processing time is so slow that the time allowed for coding in memory is reduced, the letterforms that have been seen are not recognized and are, therefore, forgotten. Others suggest that poor readers fail to use verbal mediation and rehearsal to focus attention on the relevant information in order to organize it for storage in memory — only the material most recently seen is remembered.

Aural language mediation is necessary for the visual memorization of nameable information because visual images of letters, words and objects are stored in memory as sounds rather than images. This is the reason reading errors which *seem* to be due to incorrect visual perceptions or visual memory distortions *can* be due to language difficulties involving the analysis, recall and sequencing of sounds. Children who do not use language mediation spontaneously to aid recall may appear to have general memory or information processing deficits when this is not the case (Drew and Altman, 1970).

1.1 Review of the literature and research

In an effort to determine the nature of the problems encountered by dyslexic children when learning to read, various hypotheses about the subject are reviewed below. The beginning reading strategies, reading errors and developmental sequence of typical and dyslexic children are described and the implications for instructional method considered.

Recent ideas about dyslexic readers

In an experiment by Vellutino and his colleagues (1975) that attempts to challenge some of the basic assumptions about dyslexia, poor readers in the second and sixth grades who frequently made reversal errors, were asked to copy designs, words, scrambled letters and numerals after brief visual presentation. When asked to name the visual stimuli that were actual words, they were able to reproduce the correct sequence and orientation of the letters of a word even when they were unable to name the word (they copied the word *was* correctly but called it *saw*). When asked to "read out" the letters of words after naming the whole words, they could name the letters in the correct sequence even when they named the words incorrectly.

It would appear that reversal errors such as *was/saw* result from difficulties in storing and retrieving names of printed words rather than dysfunctional visual-spatial processing.

In a series of studies by the same research group these inferences were supported. Children were asked to reproduce words from an unfamiliar writing system from visual memory. Dyslexic and normal readers were asked to print Hebrew letters and words in the proper sequence and orientation after brief visual presentation. Some children who were learning Hebrew were also tested to establish a comparison. The results indicated that the dyslexic and normal readers performed equally well on this task, but neither of these two groups did as well as the children who were learning Hebrew and had used language mediation to help them recall the letters they had seen. With the complex, word-like symbol sequences lacking in the linguistic associations of semantics and phonology, the visual recall of those symbols was just as difficult for normal than for poor readers — neither group was able to use language mediation as a memory aid.

The results imply that memory for visual symbols representing words *is* mediated by the linguistic properties of those words, particularly their meanings and sounds.

Recalling and copying *short* words from memory did not pose a problem to poor readers — only when *longer* words begin to tax the capabilities of short-term memory did writing down a symbol sequence become difficult. In order to remember a sequence of more than five to seven letters or numbers, they must be recoded into "chunks" of a more manageable size (Miller, 1956).

Fluent readers use their knowledge of spelling and word sounds to "chunk" longer words, but poor readers, without the ability to use verbal mediation spontaneously to aid memory, have difficulties recalling longer words.

The researchers found that both groups of children unfamiliar with Hebrew (normally processed from right to left) exhibited identical tendencies to process the letters from left to right suggesting that dyslexic children are not inherently impaired in their ability to maintain left to right directionality. If directionality is a problem, it would seem to be a symptom of reading disorder rather than its cause. Another inference from this study, that has been documented in other studies, is that dyslexic readers were able to hold a memory image for as long as the normal readers — the image dissipated no more rapidly in the memory of a dyslexic reader than in the memory of a normal reader indicating that visual form perception appears to be consistent in the two groups.

Since dyslexic readers seem capable of perceiving (visual ability) and reproducing (motor ability) letters as successfully as normally developing readers, the linguistic rather than the visual coding or motor system would seem to be where the problem lies.

Beginning reading strategy

Beginning reading performance is highly related to visual perception in children of kindergarten and first grade age. By second and third grades this relationship declines because *auditory*-perceptual abilities become more related to success in reading than *visual*-perceptual skills (Rudnick, Sterritt and Flax, 1967). The correlation between visual perception and reading declines with age and is connected to the complexity of the items presented. When items are more difficult, results continue to relate to visual-perceptual ability and to correlate with success in reading even to the sixth grade level (Kahn and Birch, 1968). Still the correlations between visual perception and reading ability remain relatively low because few of the skills required for visual-perceptual-task performance are the same as those involved in reading.

Higher level reading relies more on the comprehension of a language system than on the visual analysis of the symbols themselves. This is the reason that visual-perceptual weaknesses are unlikely to have a major effect on reading disability, but research suggests that weak visual-perceptual strategy in beginning reading may result in poor initial recognition of words and poor memory for phonetically irregular spellings. As previously stated, if visual information processing time is slow, it will result in difficulty recalling what is seen.

Bryden and Allard (1976) proposed that the right hemisphere of the brain, specialized in visuo-spatial functions, is more successful at processing

complex or unusual typefaces while the left hemisphere is more successful at processing simple or more common typefaces. Bakker (1979,1980) suggests that young children find *all* typeforms complex and unusual and, therefore, use their right hemisphere's visuo-spatial abilities to read them at first. As these typeforms become more familiar, they no longer appear complex or unusual and make fewer demands on the right hemisphere. After a while, reading becomes more complicated linguistically, and more dependent on meaning so that the left hemisphere, with its language analysis and sequencing abilities, begins to play the dominant role in reading.

As children acquire and develop reading skills, they shift from attending to how words or letterstrings *look*, as configurations, to analyzing how the words or parts of words *sound*, how the sounds are *sequenced* and finally to what the words *mean* without the awareness of their visual and aural details. Initial global reliance on word shape explains why very young children can recognize *Coca-Cola* or *McDonald's* with the help of context, but with little if any awareness of how the parts of words sound.

To reiterate, beginning readers can identify the components of graphic language (letter-groups or words) through:

1 *whole-word processing* based on prominent visual features and context and/or
2 *part-whole processing* based on alphabetic mapping or breaking words into their component sounds

Normally, both strategies must be utilized for the inherently difficult process of learning to identify words in order to read fluently. Some children's reading patterns differ qualitatively from normal patterns in that they overuse one strategy or the other. If the whole-word strategy is too heavily relied upon, and the sounds associated with the alphabetic characters are not used to help decode new words, although visual memory may be strong, it will be overtaxed resulting in errors such as *lion/loin* or *was/saw*. If alphabetic mapping alone is used, and prominent visual features, word meaning and context are not used to facilitate word identification, children will find it difficult to read fluently and will have a great deal of trouble with comprehension.

The nature of dyslexic reading difficulties

Vellutino suggests that dyslexia may be a highly *specific* linguistic deficiency affecting only some of the sub-skills that are necessary for reading or it may be that more *general* language deficiencies affect these sub-skills.

The first view has been supported by Liberman and Shankweiler (1972) who indicate that poor readers are often unaware that spoken and printed

words *can* be segmented into individual phonemes making it difficult for them to learn to identify words through alphabetic mapping and phonetic decoding or letter-sound synthesis.

Poor phonemic segmentation is said to be an indication of a more general problem with phonological coding characterized by the storage of impoverished/inaccurate/incomplete representations of letter sounds and word names in memory. This type of dysfunction could lead to difficulties in learning individual letter sounds and groups of letter sounds as well as names of whole words. When words are called-up from memory, having been stored without complete phonological codes, there are not enough clues retained to name the word.

Studies done by Vellutino and other investigators support the concept that the major factors in reading difficulties are deficient alphabetic mapping and phonetic decoding. The studies show that severely impaired readers are less proficient than typical readers at learning to use letter sounds to decode pseudo-words and unfamiliar words.

Kindergarten and grade one children who have some ability to segment spoken words into syllables and phonemes learn to read better later on. Most significant are studies that show children trained to identify phonemes have more ability to map alphabetically and therefore an enhanced capacity to identify printed words.

If lack of awareness of phonemes and deficient phonetic coding are rooted in fundamental problems in phonological coding, it seems likely that poor readers might have difficulties recalling words they hear.

Some investigators including Denkla and Rudel (1976a) found that dyslexic readers were slower and less accurate than normal readers in naming letters and words *and* in naming common objects, colours and numerals. Dyslexic readers' oral performance in the tests were characterized by severe blocking, circumlocutions, hesitations and substitutions (saying *dog* when shown a picture of a cat). Children with slow auditory retrieval, or *word-finding* difficulties, belabor the decoding of words to such an extent that their ability to recall and integrate information from previous words or sentences is reduced and comprehension suffers as a result (Lesgold and Perfetti, 1977).

Several investigators have come to the conclusion that poor naming is due to a structural brain deficit that hinders quick access to the linguistic information or to the codes that mediate recall (Torgesen and Houck, 1980). Some studies by Sheingold and Shapiro (1976) have shown that, in general, as vocalized or subvocalized speech in naming increases, so does success on memory tasks. Spring and Capps (1974) found that children who are unable to name objects at the rate of one per second do not even attempt to use verbal mediation as a memory aid — their recall is poor as a consequence.

Deficient vocabulary development and semantic ability make word identification difficult. A deficiency in syntactic ability may also be a factor. Several studies show that poor readers:

a seem less able to comprehend sentences, especially syntactically complex ones
b do not make use of inflectional morphemes (*-ed* and *-ing*) to specify tense and number
c seem less able to identify grammatical and ungrammatical sentences
d have difficulties in using complex sentence structure correctly and
e have difficulties in making fine distinctions in abstract (function) words like *if/but/their*

If children are unable to understand basic grammatical relations such as who did what to whom in the sentence: *The boy was bitten by the dog.* their ability to make inferences and generalizations in reading comprehension suffers (Berger, 1971). They cannot, as fluent readers do, guess at words by anticipating what a sentence will say based on content and context. For example, in a paragraph that describes last summer's holiday activities, a good reader can anticipate *ed* at the end of the word *sail* if the content of the paragraph is to make sense. Lack of awareness of these kinds of grammatical sequences makes it even more difficult for a beginning reader to understand how alphabetic sounds are segmented and ordered (Shankweiler and Liberman, 1976).

Considerable evidence suggests that poor readers find it more difficult to identify function words (*if/but/their)* than to identify content words (*cat/dog*). They also find it difficult to use context to help identify printed words, but a causal relationship between reading disability and semantic printed word attribute and syntactic processing difficulties has not yet been established.

Some researchers support the idea that children who are impaired by language deficiencies *may* be basically impaired in auditory processing. One possibility they suggest is that auditory sensory memory may be deficient — meaning "auditory trace" may be dissipated faster in poor than in normal readers. This possibility has been evaluated and dismissed by Vellutino and others. A second possibility is that poor readers may have a limited capacity to store auditory information in permanent memory.

In an investigation by Brady of the Haskins Laboratories (cited in Vellutino, 1987) of dyslexic and normal readers' abilities to remember verbal and non-verbal information (words and environmental sounds) dyslexic readers performed below normal only on the verbal portion of the memory test. These results suggest that:

a initial stage auditory processing is similar in dyslexics and in normally developing readers and that
b poor readers do not sustain any generalized deficiency in memory for auditory stimuli

These results are consistent with linguistic-coding theories of reading disability, several studies suggest that poor readers appear to be deficient in their ability to recall representations stored in long-term memory. Other hypotheses suggest non-linguistic causes of dyslexia, but according to Vellutino, "none of them is very persuasive."

Attention deficit hypothesis relates reading difficulties to an inability to concentrate or pay attention — some have found this associated with physiological abnormalities, but children exhibiting it have difficulties that are not limited to reading.

Cross-modal transfer hypothesis suggests an inability to relate stimuli perceived through one sensory mode to stimuli perceived in another sensory mode. According to Vellutino, this hypothesis suffers from a lack of experimental support and logical consistency — it is improbable that a child of average or above average intelligence would suffer from this given the degree of cross-modal transfer and learning necessary in order to reach an average score on intelligence tests.

Associative learning deficiencies, pattern recognition deficit and invariant relations hypotheses each imply such pervasive handicaps that the ability of a child to achieve even an average score on intelligence tests makes any of these unlikely. Vellutino's studies indicate that poor readers scoring low on these types of tests were limited by their linguistic coding ability — when the tests did not rely upon linguistic coding they improved on both association and rule learning tasks.

In one study a group of poor and normal readers was to learn to associate pairs of novel visual symbols with two-syllable non-sense words and then to transfer the learning task to new combinations of symbol syllable units. In a second study with a similar transfer learning task, subjects learned to associate visual pairs instead of visual-verbal associates. The significant finding was that poor readers had more trouble with visual-verbal learning tasks. "The implication was was that they had difficulty with both initial association and transfer learning because they were impaired by the inability to remember non-sense syllables, *not* by the inability to associate or generalize" (Vellutino, 1987). This was verified by a second finding which showed poor readers did as well as the normal readers on visual-visual association and transfer learning tasks.

The conclusion: poor readers have difficulties with association and rule learning only when tasks require them to store and retrieve the auditory representations of words and syllables.

Serial deficit theory, as an underlying explanation for dyslexia, suggests an inability to recall a sequence of items or events. This theory presumes that the brain has an inherent ordering ability — it seems more likely that different cognitive systems have their own procedures for establishing sequence and order.

Neurological disorders are suggested by some investigators to be associated with reading disability — more specifically, a number of different neurological disorders each of which underlies one of the basic processes necessary to learn to read. This implies a number of neurological disorders characterized by visual deficits, language deficits and cross-modal transfer deficits.

Although reading disability may result from a number of factors, the cause in an otherwise normal, intelligent child would seem to be more specific. Several researchers believe that the problem lies in the linguistic domain, but they point out that the question remains open.

There are no specific reading behaviors in dyslexic children that help distinguish them from poor readers whose difficulties stem from other domains such as limited experience. There are no distinguishable clinical patterns. All poor readers have difficulty identifying and spelling printed words, but if *dyslexia* is used as a term to define a specific reading disability in an otherwise normal child, none of those poor readers would qualify as dyslexic.

One of the most common misconceptions about dyslexia is that reading difficulties are caused by letter and word reversals. Reversal errors account for only 20 to 25 percent of errors in reading most of which are generalizations promoted by an imperfect knowledge of linguistic associates. For example:

cat is read as *fat* or
cat is read as *kitty or*
bombardier is read as *bomber*

Reversal errors can be explained by the reading strategy used. If *pot* and *top* are remembered as whole words only, without knowledge of the letter sounds, the likelihood of reversal is much greater. This was verified by an experiment done by Vellutino in which dyslexic and normal readers in the sixth and second grades learned to identify pseudo-words from a novel alphabet designed to prompt reversal errors of the *was/saw* variety. Children taught to use the whole-word method made many more reversal errors than those

taught the alphabetic mapping method, *but* poor readers made no more reversal errors than the normal readers within the groups indicating that the visual-spatial interpretation of reversal errors is incorrect. Some mirror writing can be seen in all normally developing readers as well as in poor ones — in poor readers, mirror writing is more likely to be a remnant of an earlier stage of development which they take longer to transcend. Vellutino speculates that mirror writing persisted in these children because they find it difficult to remember both the visual-linguistic cues and the cues provided by sentence context that foster accurate judgement about the relative positions of words and letters and their direction and orientation. A lack of practice in writing and spelling that *results* from a child's reading problems perpetuates the problem. Mirror writing is a consequence, rather than a cause of reading difficulties.

Another misconception is that reading disabilities are caused by perceptual deficits associated with motor and visual-motor defects or ocular defects other than loss of visual acuity. If these defects and deficits caused perceptual impairment and reading problems, how could children with cerebral palsy and visual tracking deficits become literate?

The notion that dyslexia is more prevalent in countries that use alphabetic rather than pictographic or ideographic writing constitutes another popular misconception. In a study done by Stevenson and his colleagues at the University of Michigan, there was no evidence to indicate that the writing systems of China (logographic: entire *words* represented by symbols) and Japan (logographic and syllabic: *words* and *syllables* represented by symbols) preclude reading disability.

There are no diagnostic criteria that can be used to distinguish between constitutionally and experientially derived origins of reading disability. Since dyslexia is often associated with brain dysfunction and the brain's ability to store and recall information, constitutional factors must be considered.

One very significant research finding is that boys who are impaired in reading outnumber girls by ratios ranging from 4:1 to 10:1. Many studies show that boys are in general less capable than girls on language and language-related tasks. This *could* be taken as support for constitutional and language deficit theories of dyslexia. Boys may be generally less well-endowed with linguistic capabilities or more vulnerable to neurological defects affecting language development. If it is true that reading disability is caused by limitations in language ability, constitutionally derived language defects would exhibit a higher incidence of the condition in boys than in girls.

Past studies of families and twins showed consistently that reading disability occurs more in near relatives than in the general population, that the condition occurs more in twins than in siblings and that it has a higher concordance rate in identical than in fraternal twins. These findings were

recently verified by DeFries of the University of Colorado at Boulder (cited in Vellutino, 1987).

At the Institute for Behavioral Genetics in Boulder, a group of researchers has tentatively localized a particular gene on a specific chromosome in members of families in which there is a history of reading disability. This may allow geneticists to determine which mechanisms of the gene give rise to the attribute.

Another research team from Boulder compared dyslexics and normal readers on measures evaluating electrophysiological responses to auditory and visual stimuli. The major finding was that in dyslexics electrical activity in response to reading shows greater amplitude in the left hemisphere of the brain — normally the greater amplitude is in the right hemisphere.

A group of researchers in Boston use "Brain Electrical Activity Mapping" which is based on brain function rather than structure. They obtained evidence that dyslexics left hemisphere function is qualitatively *different* from normally developing readers — this was found to be especially true of the regions of the brain known to support speech, language and linguistic activities.

At Harvard Medical School anatomical anomalies were found in the brains of several male dyslexic readers through post-mortem analysis. Anomalies included the absence of the standard pattern of brain asymmetry in language regions (atypically the left regions, normally specialized for language processing over the parallel region in the right, were no more developed than the right), and in the cerebral cortex of the language related areas there were sites where the arrangement and position of neurons was distorted especially in the left hemisphere. Scientists argue that these anomalies may reflect interference with the usual developmental process whereby undesirable neurons and connections are eliminated.

Geschwind (1970) hypothesized that these variations in the brain were related to disorders involving immune dysfunction. He suggested common mechanisms during fetal development might lead to abnormal development of the immune system and anomalous, asymmetrical development of the brain. He also suggested the possibility that testosterone played an important role in these mechanisms and that this might lead to superior development of the brain areas involved in spatial visualization and visual-motor coordination. If this were the case, investigators' failure to find evidence for the visual-spatial theory of dyslexia would be partly accounted for.

While it is true that reading speed or reading fluency may be constrained by constitutional influences, environmental factors such as wider reading experience and exposure plus improved instruction should compensate for the effects of these influences. The specific difficulties that dyslexic children encounter when learning to read that may be addressed through typographic and graphic design will be discussed in sections 1.2 and 1.3

Developmental sequence and instructional method

It is agreed that beginning readers pass through a developmental sequence that is affected by instruction. It is important to assess, at regular intervals, which methods and materials are useful to a child, how much practice of particular tasks is required and what form the tasks should take (Swartz, 1984).

Dyslexic children begin schoolwork with individual patterns of strengths and weaknesses and styles of approaching learning tasks. These ability patterns may be used to advantage or they may become liabilities in school depending on the nature of the task. "Learning success is facilitated when school tasks are well-matched to a child's ability levels and learning style" (Hunt, Joyce, Greenwood, Noy and Weil, 1974). Ideally, the classroom teacher, trained to recognize a child's strengths and weaknesses, should determine remediation objectives and creative instructional methods *for each child* in consultation with school personnel and parents.

Various theories about the origins of reading disability in general and dyslexia in particular, have given rise to ideas about instructional method. Maturational lag theorists believe that immaturity is behind reading disabilities and delays in learning, and that the ability level of the reading disabled child is qualitatively like that of younger typical children so that similar teaching methods can be used for both. Cognitive style theorists emphasize that children's predispositions toward perceiving and using information in a particular manner advance learning in some tasks and deter from learning in others (ie. *lateral-simultaneous* versus *linear-sequential* learning styles and *impulsive* versus *reflective* or *directed* versus *non-directed* learners). They believe that tasks should be matched to a child's particular learning style. For example, Coop and Sigel (1971) maintain that the conceptual style of impulsive learners is such that they do not pause and reflect on correct alternatives before responding and do not check their answers after responding. This is partly due to their global rather than detail-oriented approach to tasks. Reflective learners, on the contrary, need time to consider all the details and possibilities. They would be at a disadvantage in an activity calling for rapid information processing. Behavioral theorists believe that when a task is properly structured and reinforced even new and difficult skills can be mastered. Theorists like Bannatyne (1971) and Frostig (1980), who advocate underlying process training, believe that higher level cognitive skills cannot be acquired until any deficits are remediated. They suggest continuing academic instruction while remediating weaknesses. Other process oriented researchers believe that teaching should occur through the child's stronger modalities of information processing (Johnson and Myklebust, 1967; Sabatino and Hayden, 1970). Developmental theorists stress slowing the rate of instruction and using active remedial training with materials geared to the

students' readiness level in a warm and supportive instructional situation to facilitate learning. In all cases it is recommended that environmental factors that may deter from learning, such as poor nutrition, lack of stimulation, poor teaching, or stressful emotional climate, should be minimized or eliminated.

In the classroom the instructional models mentioned are often combined. New skills are taught through the child's stronger modalities of information processing while weaknesses are remediated through tasks that lie among academic skill hierarchies. According to Roth Smith (1983) the idea of matching tasks to stronger information processing modalities is not consistently supported in the research literature, but even though it may not help, she is of the opinion that it will not hurt. Discussion about whether children should be taught to read only through strong information processing modalities while the weaker ones are remediated or both will continue until researchers can replicate their findings.

Direct teaching

Dyslexic and other learning disabled children are often unaware of the rules and patterns that underlie the material they are being taught. According to Torgesen, Murphy and Ivey (1979):

> There is evidence that *direct teaching* of pertinent facts and concepts, and teacher guidance through rules may be just what the problem learner needs to promote greater integration and generalization of information, and an ordered approach to learning.

Koenigsberg (1973), for example, found that preschoolers only learned to discriminate *b* from *d* when it was verbally explained and shown to them using an overlay to point out the distinctive features of each letter.

Direct instruction decreases the child's confusion and increases conceptual flexibility and confidence. For example, in a task where twenty-four cards that could be sorted into four categories were to be memorized, good readers initially outperformed the poor ones, but when poor readers were trained to *look* for categories and to use mnemonic devices, their memory and, therefore, performance improved dramatically (Meichenbaum, 1977). Encouraging the active and conscious use of language mediation by poor readers, through having them subvocalize reading material, will help them to abstract, recall and generalize information and can improve their problem-solving and memory skills by focusing their attention.

The fact that dyslexic children are of average or above average intelligence suggests that, although they are experiencing difficulties in learning to read, their general capabilities should not be underestimated. The content of learning tasks should be challenging and should utilize subject matter, concepts and language levels that are equivalent to the conceptual level, vocabulary and maturity level of the student. Learning materials and methods,

optimally structured and creatively used, can enhance the teacher's ability to individualize instruction so that reading objectives are met and the child's attention and interest are sustained and developed.

Since dyslexic children often have the needs and developmental abilities of younger typical children, knowledge of the expected skill sequence in information processing can help identify weaknesses that require strengthening and strengths that can be built upon in order to establish systematically structured tasks within learning hierarchies and remedial procedures.

Visual-perceptual development

The roles of movement, stimulus-response connections and attention and discrimination are emphasized in theories of visual-perceptual development.

The movement-based theories of Kephart (1971), and other pioneers in the field of learning disabilities, stress the impact of motor action in perceptual development. Piaget's (1954) *stimulus-response* theory emphasizes the child's effects on the stimulus and vice versa. Piaget (1963) states that between the ages of four and eight, a child reaches maximum development in the ability to discriminate and recognize stimuli in the environment without resorting to physical manipulation of them. The child learns to discriminate shapes, directionality and two-dimensional spatial relationships. The theory of *distinctive features* put forward by Gibson (1969) stresses visual attention and discrimination of differences in objects and events in the environment. The child uncovers constant features and relationships between them and learns which to attend to and which to ignore. According to Gibson, the learning disabled child is not unable to perceive, but is unable to *judge* accurately which features are important to attend to and which can be filtered out of attention — these are judgements that must be taught. Studies of late preschoolers show that both handling and seeing objects facilitate learning by focusing attention on them.

Visual-perceptual skills develop so early in life, that when preschoolers are unable to match shapes or colours or discriminate between letterforms, visual processing cannot be at fault. Recent research suggests that it may be whether or not children are able to put information into conceptual use that determines whether or not they will experience learning problems.

The normal continuum of visual-perceptual development may provide a sequence of skills to guide remedial action. For example, since a preference for shape matching occurs before colour matching, children should be taught them in that order — shapes, taught first, can become the relevant cues in other kinds of matching tasks. Similarly, children should be taught to discriminate verticals and symmetrical forms before left-right reversal figures, diagonals, and asymmetrical figures. They should be taught overall configuration before internal features followed by the combination of both.

Over time, a child's ability to discriminate form develops. Preschool children have little trouble identifying figures which are perpendicular to one another —| or which differ in up-down orientation *M W*, but have difficulties with diagonals\ / and with mirror images <> (Hock and Hilton, 1979). There is frequently some confusion of upper and lower case letters. Many form discriminations do not become easy until age seven. Reversals made by typical children when learning to write usually disappear by mid-elementary school years, but they persist in learning disabled children. Learning disabled children need more information to allow them to discriminate forms in visual closure tasks — this relates to reading acquisition in that they initially spend more time scrutinizing letter shapes. Once the shapes have become familiar, they recognize them quickly by attending to their distinctive features and filling in the missing information (the direction the bowls face in *b d p* and *q*, for example) from memory (Roth Smith, 1983).

Visual-motor development

The motor movements used in copying letterforms can help in the exploration and familiarization of letters by directing the child's attention to the salient features in each form. Both visual and haptic exploration patterns improve and become more systematic as children grow older (Piaget and Inhelder, 1956). Visual matching is superior to haptic matching of forms, but there is some evidence that a combination, at times, can enhance the young child's ability to discriminate forms.

Attention and memory development

What children select to attend to depends to a large extent on visual arousal. Teaching with aids that engage children's attention by including visually stimulating colours, forms, three-dimensional or "handlable" objects and accented "task-relevant" features, coupled with verbal explanations, encourages learning.

The sequence of memory development begins with basic processes of recognition and recall, followed by acquired knowledge influencing learning and culminates with the use of mnemonic strategies.

Young children seldom use specific strategies to remember what they are taught. It is important that their attention be focused during learning tasks by *explaining* the tasks in advance and by instructing the children to name items and to detail distinctive features while presenting items in a logical sequence.

Older children (early elementary) can use long-term memory storage strategies for which preschoolers are too immature. They are able to *rehearse* aloud the words and sounds they want to remember, they can *organize* items into categories in order to help them recall them all, they are able to

verbally *elaborate* on the visual characteristics of an item in order to consolidate those characteristics in memory, they may *cluster* or *chunk* items in a series to aid recall.

> The ability to use such strategies is a developmental phenomenon too difficult for most preschool children. When they do use these strategies, they use them poorly, even after instruction. Even when taught how to use these strategies well, a child will not use them spontaneously until the early school years, and then it takes until the child is ten to fourteen years of age before they become well-developed (Hagen, Jongeward and Kail, 1975).

Language development

Young children's acquisition of language must be carefully monitored. Early intervention is critical when problems become apparent because by the time children enter school most of them have mastered major linguistic rules (Eisenson, 1972).

There are differing perspectives on how language is acquired, but the stages of language development which are well-understood help define the ways in which children with language delays differ from typical children. Awareness of the impact of language on perception, attention and memory can help explain how academic learning may be affected by language delays.

Piaget (1962) suggested that children acquire language by assimilating the language in their environment and by modifying it according to their own experience, and that their reasoning processes direct the language that they assimilate.

Children with learning/reading disabilities often experience disturbances in the components of language development (phonology, morphology, syntax, semantics, and pragmatics) beginning in the preschool years. Normally:

phonemes: individual speech sounds are mastered by children by age six
morphemes: the smallest meaningful units in words must be understood before they may be strung together in order to compose sentences
syntax: the way in which words are strung together into sentences/ grammatical structure is critical to comprehension
semantics: the meaningful connection between words and sentences, ideas or events must be mastered for conceptual understanding to take place
pragmatics: interpersonal communication ability must reach a reasonable level of competence in order for children to behave appropriately in social situations

Weaknesses in phonology and morphology generally are resolved within the elementary years, syntax may take much longer to acquire and semantics and pragmatics may pose problems throughout life.

The sequence of language development mostly proceeds in the same manner for learning disabled children than for typical learners so that a normal language-acquisition program will be of benefit.

According to Flavell and Wellman (1976):

> The proficiency with which preschoolers use language in daily problem-solving influences what they attend to, how they connect new experiences to what they already understand, and what they store in memory, recall and apply appropriately. The more meaningful, conceptually related and semantically familiar new information is to what's already in a child's conceptual system, the more memorable it becomes.

The preschooler's vocalizations or subvocalizations, strongly direct and regulate learning and behavior. "As overt and covert (inner) speech increase, so does task success" (Sheingold and Shapiro, 1976). Encouraging children to speak aloud or to subvocalize should have a beneficial effect on their learning process and recall.

Luria (1962) proposed that children gain verbal control over their behavior in three stages:

1. the speech of others directs a child's behavior
2. overt speech directs the child's behavior
3. covert speech effectively regulates the child's behavior

A normal child's subvocalizations typically become inaudible to others by age five. Self-generated instructions at this age, facilitate problem solving as much as adult instruction does. Self-instruction can be used to inhibit certain behaviors just as effectively as it can encourage them and it can have a great impact on performance.

> Language plays an important role in children's ability to use their problem-solving skills to best advantage. This language usage depends on mastery of phonemic, morphologic, syntactic, semantic and pragmatic relationships at both receptive and expressive levels, together with the intent to let language be a mediator for thought (Roth Smith, 1983).

Since reading is the translation of *language* into another symbol system, the *alphabet*, language skills relate directly to reading progress.

Reading development

According to Roth Smith (1983), experts have been unable to establish a definitive hierarchy of reading skills that would serve to guide instruction in word recognition, analysis and comprehension. Normally, a sequence similar to the one that follows is used:

Stage 1 Readiness skills to be mastered during Kindergarten to First Grade:
• top to bottom and left to right approach to the printed page • differentiation of colour • visual and auditory discrimination as preparation for word attack • verbal expression • listening skills • eye, hand and motor coordination • awareness of words and their function • the ability to follow directions • the ability to follow a story sequence • concepts and experiential background • school preparation by introduction to books

Stage 2 Beginning reading skills to be mastered by Second Grade:
• handling of books • continued development of auditory and visual perception • improvement in listening to and use of language • concept and background improvement • beginning of sight vocabulary for immediate reading and for word attack skills • letter names learned • auditory and visual perception of consonants, double consonants, blends and digraphs • use of context and picture cues to check meaning • reading aloud for changes in pitch, stress and volume • awareness of the relation of speech and print • awareness of structural elements such as inflectional variants and plurals

Stage 3 Rapid development skills to be mastered by Third Grade:
• extension of sight vocabulary and word analysis skills (including phonic and structural analysis and use of context cues) • completion of the major part of phonic analysis (including vowels, digraphs, dipthongs and variants) • wider reading experience • more fluent oral and silent reading • recreational reading begins for most children (Carillo, 1976).

The rapid development that occurs during stage three is due to gains made in auditory and visual information processing (Birch and Belmont, 1965) and attention and cognition (Wiig and Semel, 1980).

By age six, 70 percent of typical children are capable of phonemic segmentation and 90 percent of syllabic segmentation (Liberman, Shankweiler, Fisher and Carter, 1974). As mentioned, reversals are easily attended to by age seven and by age eight they generally disappear (Birch and Belmont, 1964). Mirror images like *b d* are the easiest to resolve, followed by inversions like *M W* and inverted reversals like *p d* (Kinsbourne and Caplan, 1979). By age eight children are able to read silently while subvocalizing automatically. Some of the reading errors made by typical children are as follows:

Reading errors made by typical children include:
• omitting letters in a word, syllables in a word or words in a sentence • inserting or omitting word endings • inserting extra words or sounds in words • substituting words that look or sound similar to the printed word • mispronouncing initial letters, final letters, or medial vowels • reversing whole words and the order of letters or syllables in a word • transposing the order of words in a sentence • repeating words • incorrect inflections or pauses (Roth Smith, 1983)

The reading patterns of dyslexic readers are quantitatively and qualitatively different from those of typical readers. When either the visual or the language processing abilities are overutilized or underutilized, the interaction between them that is necessary for efficient reading is never established.

The reading test developed by Boder (1973) is intended to aid in the diagnosis and development of remedial action based on a close examination of the atypical reading and spelling patterns of some children. Goodman and Burke

(1972) suggest that the reading errors made by these children are not generally *random* errors, but are rather miscues that occur as a result of information-processing preferences or past experiences that cause the child to respond to one cue or set of cues rather than more pertinent features.

Miscues generally have a visual, aural or grammatical relationship to the word presented. It is important to note whether a miscued response constitutes a grammatically correct and meaningful substitution and whether the response retains or changes the meaning of the word or sentence. Responses that retain the essential meaning of the original word or sentence such as *mom* for *mother* are less serious than those that interfere with comprehension by altering meaning such as *spit* for *spot.*

Children must master the visual and phonic elements of reading before they can recall how words look or sound in order to spell them. In some good and poor readers there is an ability to code sound by using phonologically appropriate letters that produce incorrect spelling, for example *kanvus* for *canvas*. Spelling represents what children have been able to organize, store and recall about the words they are able to read. For most children, spelling is more difficult than reading because it involves recall *and* the process of revisualization. The ability to revisualize nonphonetic elements such as the *gh* in *sight* usually follows phonetic analysis skills.

The types of errors made by dyslexic children in reading and in spelling are often similar to eachother and similar to errors made by typical children:

Reading/spelling errors made by dyslexic and learning disabled children include:
- additions *umberella* for *umbrella*
- omissions *famly* for *family*
- substitutions *mush* for *must*
- phonological spelling *sed* for *said*
- reversals *was* for *saw*
- sequencing *aminals* for *animals* (Poteet, 1980)

Motivation and learning strategies

The initial performance of dyslexic and other learning disabled children, in reading and related tasks, is often diminished by low levels of motivation (Adelman & Chaney, 1982). Externally controlled or extrinsically motivated children need immediate external incentives that match their interests in order for them to achieve. Internally controlled or *intrinsically motivated* children are usually self-motivated, but will also work for external rewards. These children should be helped to learn to attribute failure to something other than internal sources and their own self-worth, like the amount of effort put into learning the task at hand. Praising children's efforts reduces self-criticism and puts attention on what can be done to achieve.

Learning material should, as much as is possible, have transfer value to specific academic goals. In an experiment by Rosen (1966):

> . . . 600 first grade children [were divided] into two equivalent groups. One received half-hour daily visual-perceptual training while the other received extra reading instruction. At the end of one month, the perceptually trained group was superior on the perceptual tasks, and the control group was superior on reading comprehension.

Both groups learned effectively, but only one improved in reading. Clearly, subskills that are directly related to reading are of more value given the limited time available for reading instruction.

Many researchers have noted that task modifications have an extremely positive impact on the performance of learning disabled children to the extent that they believe these children are impaired by inefficient learning *strategies* rather than with deficits in their *ability* to learn (Alley, Deshler, 1979; Torgesen, 1980). However, teaching children more efficient use of their cognitive abilities will help them learn more intelligently and, therefore, will have greater long-term possibilities than continuous modification of task characteristics.

Cognitive training, as described by Flavell (1971), is based on the notion that mental and memory abilities are essentially the same:

> It has long been clear that what we know and how we think profoundly determines what and how we perceive, or speak, or imagine or problem-solve or predict; it is now becoming equally clear that all that knowledge and all that thinking also profoundly shape what and how we learn and remember . . . memory itself is mostly applied cognition . . . the human mind knows more and thinks better as it grows older, and these changes in what it knows and how it thinks have powerful effects on *what* it learns and remembers, *how* it learns and remembers, and even perhaps *when* it remembers.

Teaching efficient learning strategies using verbal mediation, visual imagery, categorization or "chunking", association, scanning, modelling and mnemonic devices can help children attend to the essential elements of their reading (and other) tasks, organize them for recall, and then to retrieve them.

1.2 Description of the target audience

In order to help determine the design criteria for the proposed product to ensure that its form and content are appropriate and directed toward the target audience, the characteristics of the user group is broadly profiled.

It is generally accepted that children with dyslexia do not constitute a homogeneous group. Despite numerous methods of teaching prereading and beginning reading, these children fail to learn to read at anticipated levels. Potential reading problems often manifest themselves in children of preschool age. Information-processing difficulties affect their ability to communicate what they already know and their ability to acquire new knowledge. If these

difficulties persist beyond preschool age, the children are at high risk for failure at academic tasks. Early intervention is critical for them.

By first grade, the typical children have enough information-processing skills to begin academic tasks that elaborate on knowledge already acquired. At the same stage, children with dyslexia still struggle to lay the foundation for learning and feel overwhelmed and confused by the demands made on them to the extent that they begin to lose self-esteem and their social development suffers as a result.

The difficulty in determining the proportion of children that suffers from reading disability/dyslexia is partly due to the lack of a common definition that can be generally agreed upon. Some estimates for the number of U.S. children that may suffer from reading disabilities are as high as 25 percent (Gibson and Levin, 1975). More conservative estimates fall in the 6 to 15 percent range (Bruinincks and Weatherman, 1970; Bond and Tinker, 1973).

The age of the target audience can only be loosely defined. On average, dyslexic children's information-processing skills lag two or more years behind their "normal" couterparts. Therefore, children who may benefit from the product developed as a result of this project may range in age from seven to ten, but may have skill levels that range from those of typical children aged five to seven or eight.

As stated, there are no specific behaviors that can help distinguish the dyslexic child from a poor reader whose difficulties stem from other domains. There are no distinguishable clinical patterns or diagnostic criteria that can be used to help establish which origins of reading disability are constitutional and which are experiential. This makes it difficult to establish a "clean sample" of children who make up the target audience. The heterogeneous nature of the dyslexic population makes it extraordinarily difficult even to *describe* members of the group in a consistent manner.

There are, nevertheless, certain characteristics which have emerged, as a result of researchers having replicated studies and compared findings, which are consistent enough to allow well-founded generalizations to be made about possible deficiencies dyslexic children may have in common that may be applicable to classroom teaching.

Children who suffer from dyslexia are generally of average or above average intelligence (they have an Intelligence Quotient of 90 or more) and many studies concur that they are four to ten times as likely to be male as female.

As discussed, the problems these children experience in learning to read probably lie in the linguistic rather than in the visual coding system, and may be due to a limited facility in using language to code other kinds of information.

The two major linguistic deficiencies that seem to characterize the problems dyslexic children have with verbal learning tasks, especially those involving words presented aurally, include the inability to utilize alphabetic mapping and the inability to utilize phonetic decoding to help decipher new words. Part of the problem may lie in that these children are often *unaware* that spoken and printed words *can* be segmented into smaller, more manageable units and sounds (morphemes and phonemes).

Language and attention abilities are interrelated in an extremely complex manner. They influence how much information is organized for storage, how much is rehearsed and how much is recalled. Dyslexic children have problems storing printed words *in* and retrieving them *from* memory — it is difficult for them to represent and access the sound of a letter, a group of letters or a word in order to help them remember it. The difficulties dyslexic children experience while trying to identify sounds are due to the storage, in memory, of inaccurate or incomplete representations of those sounds on which they draw for help. Dyslexic children are less accurate than typical readers in naming not only letters and words, but also in naming colours, numbers and common objects.

Dyslexic children *do not* appear to have problems processing the shape, sequence or orientation of visual symbols that do not have semantic or sound associations. They seem to have no inherent inability to maintain tracking direction from left to right or scanning direction from top to bottom. They have no intrinsic visual/perceptual deficits, or ocular defects and no problems with motor skills when reproducing letters, words or symbols manually. They have no inherent attentional deficits, it is improbable that they have cross-modal transfer deficits and they have no difficulties with associative and rule learning when the task does not rely on linguistic coding.

Due to the obvious intelligence of dyslexic children, their reading and learning difficulties are often not considered serious problems by parents and teachers. The consequences of a *wait-and-they'll-outgrow-it* attitude may mean not only daily failure at school tasks in the short-term, but prolonged underachievement, lowered self-esteem, alienation from peers, teachers and even parents which can lead to behavior problems, undermotivated learning, illiteracy and ultimately poor employment and lifestyle in the long-term.

1.3 Establishment of objectives and strategies

The objectives the proposed product will aim to meet, and the strategies used to address those objectives, are derived from the aspects of the problem discussed in sections 1.1 and 1.2 and will provide a focus for the form and content of the proposed design which will be discussed in detail in section 2.0.

Instructional objectives and strategies

Difficulty in reading is the major factor distinguishing children who fail from those who succeed in school (Strang, 1969). Special intervention for children experiencing difficulties is normally based on material and approaches chosen according to what children need to learn, how they learn best and which strategies need to be taught. Which materials and approaches teach which children best remains to be clarified through research. Depending on the extent of the difficulties children experience in learning to read, some may require only moderate instruction for a short period of time, others may require intensive remediation for years.

Some approaches to reading instruction emphasize the *meaning* of the material being read (visual, language experience and individualized reading methods), others stress *breaking the code* (phonics, linguistic and programmed methods). Methods that emphasize meaning are effective for children whose strengths are in visual processing and whose weaknesses include phonetic analysis, auditory sequencing, sound blending and aural recall. Linguistic methods are effective for children who are unable to analyse and sequence elements in a word. Programmed approaches are only suitable for children who can work with very little supervision. Programmed instruction, in which much of the instruction is carried by the material rather than the teacher, has several advantages: the material is presented in a logical and progressive sequence and each step requires an active response so that attention is sustained more easily. The children are provided with motivation through instant feedback and can progress at their own rate without feeling pressured or embarrassed by impeding others. The disadvantage of programmed learning lies in the lack of contact with a warm and supportive teacher or parent.

According to Rosner (1975), many experts agree that most children respond best to phonetic methods that teach the decoding and sequencing of sounds. Once the *code* has been mastered, the ultimate objective, comprehension, can become the focus of reading.

Concerning the content of learning materials, Krieger (1981) states:

> Since fluent reading necessitates the recognition of words at a glance, gaining meaning from words, as well as the analysis, sequencing, and retrieval of sounds, no one process can be concentrated on to the exclusion of another. It makes sense to teach reading largely within content materials rather than just words lists since context aids word recognition and since the child's reading errors eventually become regulated by the semantic and syntactic constraints of a passage.

That meaningful instructional materials are more effective was proven in a study by Ebbinghaus (1973) in which a group of children had forgotten 60 percent of material learned by rote after an hour had passed.

The amount of *time* spent on reading instruction using special learning materials is an important factor that is easily overlooked. A study by

Zigmond, Vallecorsa and Leinhardt (1982) shows that a group of learning disabled students spent an average of 27 minutes per day on reading, while they spent an average of 55 minutes per day on waiting, "getting ready", finding materials and cleaning up. Clearly, more time spent on reading instruction and reading practice would result in improved reading performance for these children.

Approaches to reading that capitalize on learning strengths can lead to progress, but for children with severe problems, it may be necessary to modify the curriculum to include special reading strategies or special alphabets.

Learning to read English necessitates learning to deal with words only approximately 50 percent of which correspond to phonetic rules (Hanna, Hodges and Hanna, 1971). Spelling, a very unreliable guide to pronunciation, does not correspond with individual letter sounds as exemplified by the medial vowels in the words *hat and many*. To add to the confusion, several letters may represent a single sound as in the *double o* sound in *through*.

Dyslexic children find it especially difficult to remember the sounds of the letters, the rules that govern their pronunciation and their configurations in order to revisualize them. Instructional strategies that employ special alphabets or tools may aid beginning readers in mastering these irregular relationships and help them to learn to read.

According to Vellutino (1987), not enough is yet known about how the brain works to devise activities that would have a direct and positive effect on the neurological functions responsible for basic visual perception, cross-modal transfer and serial memory. He states, "More conventional approaches to remedial instruction have had greater success, particularly in educational settings equipped to provide dyslexics with the type and amount of help they need." He and his colleagues stress that early remediation should be based on intensive, individual tutoring and on a reading program that uses both the holistic/meaning and the analytic/phonetic approaches. Reading training should be supplemented with activities that foster language development. This type of training can help a dyslexic child develop functional reading skill.

The interaction between objectives and strategies

The *objectives/strategies tree* that follows, based on the list below, renders visible the relationships and interactions between the various strategies aimed at meeting different aspects of the objectives (Cross and Roy, 1976).

The **primary objective**, to facilitate beginning reading for the dyslexic child through the typographic presentation of language, can be subdivided into three aspects of remediation represented by the **secondary objectives**:

1.0 **motivational remediation:** motivate and inspire the learning and use of basic reading skills
2.0 **prescriptive remediation:** equip the child with the basic skills necessary for efficient beginning reading and
3.0 **operational remediation:** teach and reinforce efficient learning strategies for beginning reading skills

The secondary objectives imply several **tertiary objectives** which address more specific issues — the need to:

1.1 attract and sustain the child's attention and interest, **1.2** reduce the child's sense of anxiety about learning to read and **1.3** build the child's confidence and self-esteem
2.1 teach basic reading skills and strategies while identifying inadequate basic reading skills and strategies and
3.1 familiarize the child with the features of visible language, **3.2** familiarize the child with the features of audible language and
3.3 use instructional methods that will consolidate the child's knowledge of the skills to be learned

Stemming from the tertiary objectives the **strategies** begin to suggest courses of remedial action to address the specific issues identified above. They indicate the necessity to:

1.11 arouse the child visually through the use of images and colour, **1.12** use handlable, preferably three-dimensional objects, **1.13** use meaningful material in a playful manner, **1.14** require an active response and **1.15** give immediate feedback or an external reward
1.21 minimize any detrimental environmental factors, **1.22** provide a warm, supportive instructional environment, **1.23** use a systematic, predictable activity structure, **1.24** adjust the rate of instruction for the abilities of the individual and **1.25** use humor in learning material to alleviate stress
1.31 encourage and praise the child's efforts at learning to read, **1.32** capitalize on strengths and intelligence, **1.33** use material of an appropriate level, **1.34** attribute errors to external sources and **1.35** grant reward or special privilege

2.11 address specific problem areas in reading such as difficulties with **a** phonological coding, **b** alphabetic mapping, **c** whole-word processing (using context and visual features), **d** chunking of longer words (into smaller, more manageable parts), **e** verbal mediation to aid memory,

f content and non-content word meaning, **g** vocabulary development, **h** print-object relations awareness and naming and **i** analytical skills and grammar

3.11 show formal features of upper and lowercase letters, **3.12** show formal features of characters from the two most common font types, **3.13** lay out material in a meaningful arrangement, **3.14** support meaning with images and **3.15** use graphic cues to aid letter and word **recognition**

3.21 analyze phonetic features of language, **3.22** encourage vocalization and sub-vocalization of sounds while reading, **3.23** encourage verbal elaboration of activities, **3.24** encourage self-instruction during activities and **3.25** use graphic cues to aid **pronunciation**

3.31 apply concepts using problem-solving activities, **3.32** employ mnemonic devices, **3.33** rehearse and repeat pertinent information, **3.34** teach organization and categorization skills and **3.35** use graphic cues to aid **memory**

Objective

Facilitate beginning reading for the dyslexic child through the typographic presentation of language

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1.0 Motivate and inspire the learning and use of basic reading skills

1.1 Attract and sustain the child's attention and interest
  - **1.11** Arouse the child visually through the use of images and colour
  - **1.12** Use handleable, preferably three-dimensional objects
  - **1.13** Use meaningful material in a playful manner
  - **1.14** Require an active response
  - **1.15** Give immediate feedback or an external reward

1.2 Reduce the child's sense of the anxiety about learning to read
  - **1.21** Minimize any detrimental environmental factors
  - **1.22** Provide a warm, supportive instructional environment
  - **1.23** Use a systematic, predictable activity structure
  - **1.24** Adjust the rate of instruction for the abilities of the individual
  - **1.25** Use humor in material to alleviate stress

1.3 Build the child's sense of confidence and self-esteem
  - **1.31** Encourage and praise the child's efforts at learning to read
  - **1.32** Capitalize on strengths and intelligence
  - **1.33** Use material of an appropriate level
  - **1.34** Attribute errors to external sources
  - **1.35** Grant reward or special privilege

2.0 Equip the child with skills necessary for efficient beginning reading

2.1 Teach basic reading skills and strategies while identifying inadequate basic reading skills and strategies
  - **2.11** Address specific problem areas
    - a phonological coding
    - b alphabetic mapping
    - c whole-word processing
    - d chunking longer words
    - e verbal mediation
    - f content/non-content word meaning
    - g vocabulary development
    - h print-object relations/naming
    - i analytical skills/grammar

3.0 Teach and reinforce efficient learning strategies for beginning reading skills

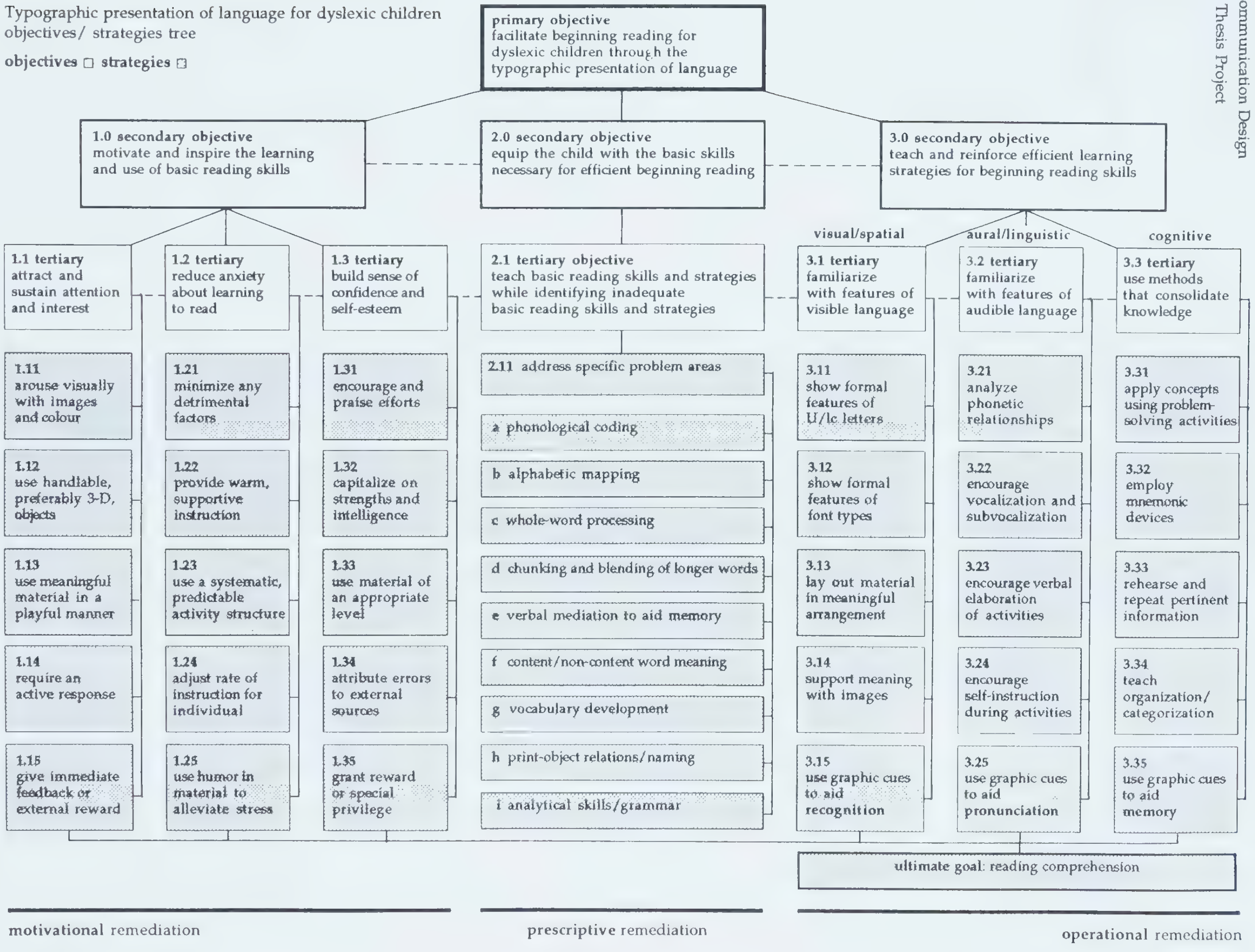
3.1 Familiarize the child with the features of visible language
- **3.11** Show formal features of upper and lowercase letters
- **3.12** Show formal features of the two most common font types
- **3.13** Lay out material in a meaningful arrangement
- **3.14** Support meaning with images
- **3.15** Use graphic cues to aid **recognition**

3.2 Familiarize the child with the features of audible language
- **3.21** Analyze phonetic features of language
- **3.22** Encourage vocalization and sub-vocalization of sounds
- **3.23** Encourage verbal elaboration of activities
- **3.24** Encourage self-instruction during activities
- **3.25** Use graphic cues to aid **pronunciation**

3.3 Use methods that will consolidate the knowledge of skills to be learned
- **3.31** Apply learned concepts using problem-solving activities
- **3.32** Employ mnemonic devices
- **3.33** Rehearse and repeat pertinent information
- **3.34** Teach organization and categorization skills
- **3.35** Use graphic cues to aid **memory**

Typographic presentation of language for dyslexic children
objectives/ strategies tree

objectives □ **strategies** ▨



1.4 Analysis of existing instructional materials

There are many special approaches and numerous materials available for use in the field of remedial reading instruction. A selection of existing learning materials in the field is discussed, and the form and content of each is evaluated, to provide a context within which to consider the development of design components to be used in the proposed designs.

Prereading materials and methods

Prereading materials and methods are often geared towards visual-perceptual tasks which provide the basis for learning letter discrimination. The correspondence of letters to sound (grapheme-phoneme) is often neglected at this stage of instruction.

The Frostig-Horne Visual Perception Training Program *Frostig-Horne (1964)*

Designed for prereading or remediation training, this program includes eye-motor coordination, figure-ground recognition, perceptual generalization training and other exercises intended to train or remediate visual perceptual and motor disabilities only, so that although it may be suitable for *prereading* training, it is not directly aimed at teaching beginning reading skills such as letter recognition.

The Visual Patterned Alphabet (VPA) *Nelson and Frascara (1977)*

The visual patterned alphabet was created not to teach reading, but in an effort to improve the prereading skills of children who are at risk of developing reading disabilities. Designed to improve children's knowledge about the physical structure of letterforms, the VPA assists them with letter discrimination by providing letterforms with patterned backgrounds which enhance the distinctiveness of different letters and the similarities of the same letters, from different cases or fonts **appendix 1**. Instead of using the traditional methods of teaching letters by coupling them with pictures of objects, or with colours and symbols (Bannatyne, 1966; Gattegno and Hinman, 1966), theories of visual information processing were used to arrive at this method of "labelling" letterforms with two-dimensional background patterns. VPA tiles are used for letter sorting, letter matching, association matching and memory matching tasks. The abilities of children of average or superior reading readiness did not seem to improve after using this system. This lead the developers to infer that the VPA aids in the acquisition of prereading skills only. The advantages of this system are the speed with which gains in letter recognition are made (after only seven hours of training), its direct transfer to print and the economy of its production. It does not, however, attempt to deal directly with aspects of sound.

Beginning reading materials and methods

Several specialized methods have been developed that either replace or supplement a standard reading program. The materials that follow deal, to varying degrees, with the linguistic aspects of reading and with trying to facilitate the process of decoding print (analytic/phonetic aspects) in order to allow meaning to be attended to (holistic/meaning aspects).

Words in Color *Gattegno (1962)*

This system uses 47 colours to code English language through sign to sound association cues. Each speech sound is consistently coded regardless of the letter combinations that make up the sound. The long *a* for example is always coded green whether it is represented by *a/ai/ay/ea/ei/ey* or *eigh*. The traditional alphabet is used for reading and spelling and is colour coded by the children helping them to understand the relationships between the temporal nature of spoken speech and the spatial arrangement of print on the page (Gattegno, 1968). Teaching is done from examples printed on wallcharts (or written on the blackboard) while the sounds that correspond to the letters are dictated. The premise behind the system is that decoding should be facilitated so that meaning can be attended to and so that the children feel they are making rapid progress and gain confidence. The following example illustrates how the system teaches blending:

pa	*ap*	→	*pap*
pink/brown	brown/pink		pink/brown/pink

When the sample is considered in relation to conventional spelling, confusion might result in the reading *peep* as *peep* rather than *pep* as intended. The information in the charts and work books is presented in a manner that renders the relationships between elements to be attended to as uncertain and the reading direction on the page is not clearly established **appendix 2**. Sentence building begins without the use of uppercase letters or punctuation which can aid stress and intonation in silent and oral reading.

The principal disadvantages of this system are that it is difficult for the teacher to have 47 colours of chalk on hand, that there are no sustained reading materials available printed in the code (which is understandable since the cost of producing full colour reading material can be prohibitive) and that the system would be ineffective with colourblind children.

Initial Teaching Alphabet or i/t/a *Pitman (1964)*

In this 44 character alphabet, each symbol represents one speech sound. For example, letters that sound alike, *k* and *q*, share a symbol and digraphs that represent a single sound, like *sh* and *th*, are each represented by a single symbol **appendix 3**. Spelling is determined by pronunciation:

face = ***fæs*** *time* = ***tiem*** *home* = ***hœm***

The sound of each symbol is taught and the children are instructed to write them in lowercase letters only. At the beginning of the second grade, the *ita* characters are phased out in favor of the traditional alphabet. A proposal was made to adapt Pitman's augmented alphabet to allow normal lowercase characters to be used facilitating the production of printed materials. In the adapted version, *x* was replaced by *ks* and *q* by *kw*.

The problem with this system is the confusion that arises during the transition period when spelling rules are changed and uppercase letters are introduced. This period is challenging to all children, but especially to reading disabled/dyslexic children (Heilman, 1968).

The Color Phonics System *Bannatyne (1966)*

In contrast with *Words in Color*, which is highly organized, this system allows children to organize their own content. The letter sounds do *not* all have corresponding colours, but *are* used as decoding aids. The lack of systematic organization and the transition to black and white type from coloured type may cause confusion (Bernstein, 1967).

Peabody Rebus Reading Program *Woodcock and Clark (1969)*

This system replaces traditional printed words with a *rebus*, a visual symbol that is purported to provide a simpler link with spoken words than do written words. The rebuses in the program are linked with written words so that, on completion of the program, 100 words can be read. The advantages of this system is that it capitalizes on visual perceptual abilities that are often strong in dyslexic children, it emphasizes the use of context clues in word perception and focuses on the analysis and blending of sounds while giving beginning readers a sense of what the process of reading is like. The response system used in the workbooks gives the child instant feedback. It indicates, by changing the colour of the printing ink in the workbooks (on contact with water) whether or not a correct response has been marked. The disadvantages of the program are that it does not link *sounds* with *letterforms* and, therefore, does not teach the

decoding of *print* effectively and that, from a visual standpoint, the illustrative material appears dated, static and uninteresting.

The rebus idea has been adapted to letterforms **appendix 4** to help in the learning of phonic skills in order to aid children in the decoding of unfamiliar words – the theory being that the association of a letterform with an object that is related to the letter in its *shape* and begins with its *sound* will aid in the recall of both. Although the illustrations may serve as mnemonic devices that help children recall the shapes of individual letterforms and their sounds, it is unlikely that they will teach sufficient phonic skills to enable children to decode unfamiliar words. The *real* value of the rebus system is as a bridge between spoken and written language.

The Gillingham Stillman Method *Gillingham and Stillman (1970)*

Based on Orton's theories, this highly structured method is alphabetic and emphasizes the sounds of letters, but does not deal with the meaning of whole words. The exceedingly gradual approach requires instruction five times per week for at least two years. Sounds are first learned one at a time using multisensory methods (which will be discussed in the next section), then blended into sound groups and finally into whole words. Spelling and writing are stressed.

Alternative materials and methods

Approaches to remedial reading instruction often train specific perceptual or motor capabilities. They may improve on a child's performance of the specific tasks trained, but the improvements do not transfer directly to reading performance.

The non-linguistic theories of dyslexia, that have been challenged in favor of language deficiency theories, have each given rise to remedial techniques designed to correct the cognitive defects outlined in them. If the logical and empirical evidence and arguments against them are valid they must be questioned. The research evaluating them seems to have produced no convincing arguments to support them and in some cases there is even strong evidence against them.

Most of these methods follow what has been called a *multisensory* approach which is based on the notion, first put forward by Fernald (1943), that focusing attention on the distinctive features of a task, involving all the senses in the learning process, may facilitate learning **appendix 5**. These methods may be helpful to some children, but for others there is the danger that the sensory *bombardment* may overload them and "tune them

out" (Johnson and Myklebust, 1967; Kirk and Kirk, 1971). Dyslexic children would almost certainly find the tasks tedious.

The VAKT (visual-auditory-kinesthetic-tactile) Method *Fernald (1943)*
Words are taught as wholes, never as individual sounds, using multisensory activities. The disadvantages of this method are that progress is very slow as mastery at every stage is considered essential, that it relies heavily on the child's ability to generalize and that the extremely repetitive nature of the activities would almost certainly be boring to many bright dyslexic children.

The Neurological Impress Method *Heckelman (1969)*
Auditory modeling is used in this approach. The child and teacher read aloud together as the child points out the words. The teacher's voice becomes progressively softer as the child's confidence and ability in oral reading increase. Some side benefits of this method include the creation of a strong bond between teacher and pupil, increased motivation and confidence because of the feeling of security in the learning situation and improved oral expression and verbal fluency by the child. This method does not, however, deal with decoding skills.

The Fitzhugh Plus Program *Fitzhugh and Fitzhugh (1975)*
This program is intended for use by children with various learning disabilities including dyslexia. Nine workbooks designed to supplement the curriculum are meant to be used as remedial material and as preparatory material to enhance reading readiness. A problem oriented approach, it uses repetition to reinforce learning. There is a very gradual increase in the degree of difficulty of the tasks, which according to the originators, ". . . insures success and thus provides constant motivation." Children are meant to work alone, if they are able to, at their own pace.

The response system utilizes a coloured felt pen that indicates, by changing the colour of the printing ink in the workbooks on contact, whether a correct response has been marked providing instant feedback, a strong motivational force.

The workbooks in the *Spatial Organization Series* include *Shape Matching, Shape Completion and Shape Analysis and Sequencing* **appendix 6**. The abilities to be trained here (visual acuity, visual discrimination and memory, left to right eye tracking, rotation, motor memory, and fine muscle coordination) are not a problem for dyslexic children and there is little or no transfer of the skills trained to reading skills. None of the forms to be matched, completed or sequenced are letterforms, so that not

even letter or word recognition or familiarity with letter shapes is dealt with.

The *Language and Numbers Series* contains, apart from workbooks for arithmetic operations, *Alphabet and Common Nouns, Action Verbs* and *Grammar and General Knowledge.* The *Common Nouns workbook* includes alphabet recognition training "by use of a cueing device" and noun recognition is reinforced with picture/word association. There are, however, some design flaws in the presentation of the information that may affect responses made to the questions **appendices 7 and 8**. The stimulus letter, for example, is taken from an *uppercase* and *sans serif* font, while the response cues are taken from a *serif* font and uppercase initials followed by smaller uppercase letters are used, which bear little resemblance to the upper and lowercase letters that are most legible and most often used in printed text. Vertical relations between the stimuli, are stronger (based on the perceptual principles of similarity and proximity) than the horizontal relations between the stimulus and array of response alternatives which should be inherent in the presentation of the problem.

Some of the response alternatives are ambiguous, further confusing children who are likely already insecure about their abilities to perform. In the grammar problems, where one word must be selected from a group of alternatives, the horizontal presentation of the alternatives in a sequence is less clear, and therefore less appropriate than a vertical "list" of alternatives. The few sections of this program that *are* appropriate for dyslexic children are presented in a way that makes them unnecessarily difficult to work with. These kinds of difficulties must be eliminated from learning material for dyslexic children.

Remediation of Reversals Kirschner (1977)

This system uses motor pretraining, of the kind used by Fernald (1943) and Montessori (1961), and is intended to "automate" the child's "sense of direction" through the visualization of components in the system by children when difficulties with specific letter reversals arise.

Based on the principle of providing an error-free visual-motor pattern, the "rulers" provided **appendix 9** are to be used to "draw" the letterforms beside the marked areas. Although this system may provide some practice in drawing individual letterforms, it certainly does nothing to help children learn letter *sounds* in order to help them eliminate the problem of letter and word reversals at the source. In addition to the fact that the premise behind this system is misguided, there are several design flaws in the visual presentation of the information that make this material less than optimally functional even as it is. Letterforms are presented and repeated too often outside the context of a word.

On *worksheet 2* **appendix 9** the illustration for *nails* is ambiguous – it could just as well be *hammer* except for the tiny arrow pointing to the nails – and in the word examples, where a missing letter is to be filled in, there is no visual indication given that a letter is missing. In many cases, the boxes provided for missing letters do not allow for letters with ascenders and descenders. The illustrations are static and uninteresting – occasionally even unrecognizable (the *map* on *worksheet 7* for example) and the relationship between words and their corresponding images is weak. Illustrations are visually more prominent than the words which are to be learned . If the words and corresponding images were better integrated, these word/image combinations could serve as mnemonic devices. The typeface used is a *condensed sans serif* font which, because of its tall, narrow form, reduces inter and intra letter spacing and makes the individual identities of the letterforms more difficult to perceive. This program does familiarize children with difficult-to-discriminate letterforms through repetitive practice, but it is no more useful to dyslexic than to typical beginning readers.

Braille Phonics *Fishbein (1979)*

Braille, the alphabet of the blind, has been used as an aid to teaching children phonics. Fishbein (1979) states that children with strong auditory processing abilities can benefit from this approach. It does combine the use of tactile, phonic and visual information processing systems which might facilitate learning, but with the transfer to print, two entirely different systems of symbolization must be learned.

The Manual Alphabet *Vernon, Coley and DeBois (1980)*

The alphabetic sign language of the deaf has been used to try to remediate reading difficulties. Although some children may benefit from this multisensory approach, when it comes to reading print, the transition from this manual symbolization system of the alphabet to the written and printed characters may be confusing and waste valuable time.

Of the more sophisticated materials and methods available to aid in the instruction of reading disabled/dyslexic children (educational television, computers, talking typewriters, tape recorders, tachistoscopes, and other "teaching machines") many rely on pieces of equipment that may be *available* through school systems, but may be difficult to *access*. This kind of equipment is almost never available in the home environment and so the amount of time a child may benefit from its use is necessarily limited. Attractive, functional, inexpensive and easily accessible materials that can be utilized to teach the coding of speech to print would afford more children, parents

and teachers the opportunity to use those materials more easily and more often. A proposal for affordable, "low technology" instructional beginning reading materials for dyslexic and typical children that fit the descriptors listed above is made in section 2.0.

2.0 Facilitation of beginning reading through typographic design

To provide a focus for form and content of the proposed visual communications, the objectives/strategies tree developed in section 1.3 is used as a reference to help determine the kind and number of issues requiring attention that may be addressed effectively through typographic design.

Despite appropriate content and attention to teaching methods, the typographic and graphic design of educational material is often ineffective, sometimes producing undesirable results due to the deterioration of communication which interferes with the ability of the individual to learn and retain the content. "A society more aware of, and attuned to, design and communication would not tolerate such educational material. . . . Only good visual design makes communication communicative, information informative, and therefore useful (Langer, 1989)."

Any child learning to read must be made aware of the rules for transferring speech sounds into print and the conventions of representing spoken language graphically. The functions of the components of visible language must be learned. In addition to recognizing that the same letter can have different sounds in different contexts (*man/many*) children must learn that the same sound can be represented by different letters (*a/ai/ay/ea/ei/ey/eigh)* and that the same letter can be represented in different ways (A/a/A/ɑ).
Before phonetic instruction can begin, the child must understand the physical structure of print, the relation between letters, their order, sequence, direction and the relations between print and objects.

The results of studies by several researchers confirm that **the addition of visual cues to letterforms** can help children learn *pre-reading* skills (Nelson, Frascara and Nilsson, 1985; Bannatyne, 1966; Gattegno and Hinman, 1966) and that *beginning reading* can be facilitated by increasing the availability of responses through the use of context and associative connections between words (Taylor, and Taylor, 1983). For dyslexic children, beginning reading might be facilitated by emphasizing the context for and associative relationships between words and by using **visual cues and presentations that schematize and clarify the relations between letterforms and letter sounds** helping the storage and retrieval of linguistic information and simplifying the processes of decoding and recoding visible language to sound so that meaning can be attended to.

Definition of linguistic terms

Phonemes

English language uses some 40 phonemes or speech sounds, but the alphabet contains only 26 characters or letters symbols. As stated, many single characters represent more than one sound and many sounds can be represented by different letters or letter combinations. There are phonetic differences in English that are not phonemic (the *p* in *pen* or in *spend).* The criterion used to establish if two sounds belong to the same phoneme is whether one sound can substitute for the other without changing the meaning of a word (Taylor, and Taylor, 1983). The two main classes of phonemes in any language are *vowels* and *consonants* (see **appendix 10**).

Diphthongs

Diphthongs are smooth sequences of two vowel sounds like the *ou* in *shout.*

Syllables

Units of sound that contain one vowel or diphthong and often one or more consonants are called syllables.

Morphemes

The smallest meaningful units of language, word stems or affixes, prefixes and suffixes, are called bound morphemes. Word stems are called free morphemes.

Graphemes

Units of writing that contain single letters or letter clusters which represent single phonemes or speech sounds are called graphemes.

Abstraction of phonemes from the alphabet

When letter to sound correspondence is irregular and complex, as it is in English, beginning readers encounter problems in learning to read. An analysis of all the possible ways of presenting, through writing or print, the 40 or more English phonemes, shows that there are more than 2000 alternate graphemes as illustrated by the following list of words: *buy/neither/isle/aisle/indict/my/mind/eye/tie/rye/sign/guide* or the phrase *to go on* (Wallis Burke, 1975). Children learning to read English store some 50,000 words in long-term memory. **Information that is difficult to retrieve from long-term memory can often be retrieved with an appropriate cue.** In a sound based writing system such as the alphabet, words can be phonetically broken into syllables (children are able to do this at about age 4) which must then be broken into phonemes. This analysis is relatively difficult for all children who are learning to read, but it is especially troublesome for dyslexic children.

Direct teaching of the analysis and synthesis of the features of audible and visual language, with the help of **visual cues, both typographic and spatial, to aid recognition, pronunciation and memory,** may facilitate decoding of print for dyslexic children allowing them to attend to the meaning of a text in order to understand what they have read.

2.1 Study of the interactions between objectives and strategies

Issues falling under each of the three categories of remediation determined and listed in section 1.3 (motivation, prescription and operation) are addressed.

Consideration of instructional requirements

In learning oral language, there are frequent opportunities for children to respond to learning material and to get immediate aural feedback. In learning written and printed language the situation is just the opposite. An instructional program should be designed to provide the child with **opportunities to respond** to learning material and frequent **reinforcement of correct responses** affording the child the opportunity to experience success and increase self-esteem. **Motivation to learn** will be optimized when attention is maintained, through the use of **attractive and meaningful material**, and when correct responses to the most relevant and critical elements of learning material are reinforced. Motivation is as important as instructional technique. According to Nelson and Frascara (1977) the child's **reward of meeting the challenge** and applying learned concepts in order to solve a problem consolidates knowledge and is likely as good as praise and is, therefore, a sufficiently motivating force.

The analysis and synthesis of language is learned aurally. Bruner et al (1966) asserts that psychological activities, like the interaction between internalized speech and cognition during reading, make the analysis and synthesis of language possible because language is discrete:

> *Discreteness* in language refers to the fact that at the sound level of meaning, the material of human language is discontinuous: there is no intermediate step between *bin* and *pin* that produces a word: /b/ and /p/ are discontinuous phonemes, and should one voice a word that was a sound midway between, the hearer will interpret it as one phoneme or the other. So too with words or morphemes . . . . What this imposes on the speaker of human language is the requirement that he analyze the domain of sound and of sense into discontinuous components that can then be constituted into a message . . . . Analysis and synthesis are literally *forced* on anyone who would speak a human language. Language, then, breaks up the natural unity of the natural world – or at least imposes another structure on it (Bruner, Olver and Greenfield, 1966).

Rendering visible the relationships between the components of sound and the visual patterns in language may facilitate some aspects of beginning reading.

Gibson (1969) indicates that reading ability is directly related to language ability, that the first stage of learning to read is acquiring spoken language and that the second is learning to decode written language to speech. For all children, but especially for dyslexic children, this second stage should be facilitated by direct instruction of whole-word processing, alphabetic mapping and phonological decoding strategies using material that includes **graphic identification of similar sounds made by different letters, letters having different sounds in different contexts and visual cues for chunking, and blending sounds and for pauses and stresses in reading material.** These strategies should simplify the process of making discriminative responses to graphic language allowing greater attention to word meaning and ultimately comprehension of text content.

The meaning of individual sentences can be and often is understood from content (concrete) words and word order alone. Content words may be interpreted semantically, but syntactic morphemes or function (abstract) words depend more on phonological coding to be understood. **Identification of content words** may be facilitated through the use of appropriate illustrative material for reinforcement. **Identification of function words** depends on phonetic decoding which may be facilitated by graphic cueing.

Since reading ability is contingent upon language ability, ideally, vocabulary development should be built into the learning material that *precedes* the teaching of decoding, but vocabulary should be further developed *during* the teaching of decoding by **using unusual or humorous textual materials that act as motivational and perhaps mnemonic devices.**

Aural/linguistic considerations

One of the most persistent questions in reading and related research is whether language mediation is necessary for the derivation of meaning. Phonological mediation may play a major role in the later stages of processing like rehearsal and recoding in abstract memory. Massaro (1979) concluded that **language mediation is important to storage in short-term memory**, but not to initial processing for meaning.

In a study that explored the strong association between short-term memory and verbal coding in normal adult readers, Baddeley (1984) found that items presented visually would only be registered in the store if the material was articulated subvocally, but that for items presented aurally registration in the store was compulsory. Subvocal rehearsal helped the reader revive fading memory traces and reinforce visual stores with more durable phonological stores. Baddeley and Lewis (1981) found:

> . . . that there are probably at least two phonological codes. Coding by articulation appears to operate in parallel with other reading processes since it does not slow down reading, and appears to increase accuracy but is probably not necessary for

> comprehension of gist. There is almost certainly a second phonological code which is sufficiently powerful to allow rhyme judgements, but does not appear to contribute to verbal memory.

Phonological coding is important in maintaining the order of input stimuli and recall through rehearsal. Information about sequential order appears to be an integral component of phonological coding. Verbal matter which is critically dependant on ordering of elements, such as spelling and syntax, suffers when phonological coding is defective. **Subvocal rehearsal should be encouraged in an effort to reinforce phonological coding and improve memory.**

In a study of dyslexic boys (aged approximately 14 years), Baddeley and his colleagues found that their digit span (the number of items in a sequence that could be recalled) was impaired, as is characteristic of developmental dyslexic readers, but that, contrary to the findings of Liberman et al (1977), their use of phonological coding while reading appeared to be relatively normal. This may be explained by the work of Siegel and Lindner (1984) who suggest that phonological coding is impaired in poor readers of a sufficiently young age. Baddeley's subjects were many years older than the other children tested, suggesting that there is a developmental lag in the subsystem of short-term memory that deals with the use of subvocal rehearsal strategy in order to retain visually presented material. As previously mentioned, language mediation (the subvocal rehearsal strategy) is not often used by very young children, but is usually evident by age 10. Although it may be utilized in a normal way, it may still be inefficient and may be improved through direct training.

Many dyslexic children find it difficult to distinguish between words that begin with letter sounds that are similar like ***bat and pat***. Direct instruction **differentiating between aurally confusabe letter sounds** such as *p/b, c/g, m/n, t/d, f/v* and *w/x/y/z* (Miles and Miles, 1975), **through the use of graphic cues** for emphasis, might be helpful in overcoming reading and spelling errors which can be attributed to a lack of attention to aural detail. When a dyslexic child attempts to read a word, after "sounding out" all the individual letter sounds correctly, the sounds must be recalled and blended. By the time the last letter (which may fall outside the digit span range of the child) has been reached, the first sounds have been forgotten requiring the process to begin again.

For a normal child the "sounding out" strategy can be extremely effective, but even then there are problems inherent in English orthographic irregularities, like letters appearing late in the word that alter the pronunciation of earlier letters. The final *e* changing *fir* to *fire* necessitates the recoding of the medial vowel *before* blending sounds. This process increases the likelihood of forgetting the sound sequence, making it very difficult to read the word.

Another problem lies in the encoding of individual consonants. The usual strategy is to add an *uh* sound so that *sing* is decoded as *suh-i-nuh-guh*. The difficulty in recalling a sequence of several similar sounds makes the blending of the word extremely difficult for a typical child and nearly impossible for a dyslexic child. The use of this strategy makes it easy to see how a child might decode the individual letters of a word correctly, but come up with an incomplete blend, like *back* for *black*, due to short-term forgetting (Baddeley, 1984). If **pronunciation irregularities,** such as vowel sounds changed by terminal *e's*, are **made visible through the use of graphic cues**, it might simplify the decoding of these sounds.

Baddeley (1984) suggests discouraging children from decoding individual consonants and encouraging them to decode in consonant-vowel pairs or clusters instead, so that *sing* could be decoded as *si-ng* or as *s-ing*. This strategy will **reduce the number of chunks that must be held in short-term memory** and enable the child to decode and recall all the sounds in the word.

Building a phonological mediation strategy into beginning reading instruction and using instructional materials with strategic graphic cues that aid pronunciation by rendering visible letter clusters and irregularities in spelling patterns that mediate word recognition (Gibson, 1965, 1971) might lead to improved decoding and recall for both dyslexic *and* typical children.

Visual/spatial considerations

Since the research indicates that dyslexic children do not have problems with visual memory or with the visual processing aspects of reading, it seems reasonable to suggest that **visual cues and strong visual design** might be effective in providing additional information that might help dyslexic children attend to aural/linguistic aspects of reading which are the most difficult for them.

The study of functional cues in **letter recognition** is one of the oldest areas of reading related research. Most of the studies have been done by designers and typographers concerned with the quality of aesthetic design and legibility of character sequences. Many of the early conclusions they reached are still valid, but are generally ignored in the contemporary study of letter recognition. Several researchers have investigated letter recognition by using confusion matrices to determine underlying stimulus dimensions (Townsend, 1971), by examining the radical effects of lateral interactions between adjacent letters (Bouma, 1970, 1973) and by degrading detail through length or manner of presentation. Most of these investigations test the recognition of single letters in isolation, so the conclusions drawn about functional cues in letter recognition do not necessarily apply to letters in the context of a word.

Gibson (1969) defined certain distinctive visual features for the recognition of uppercase letters — Bouma (1971) for lowercase letters, but the

legibility of *print*, consisting of upper *and* lowercase letters, was, and is, largely determined by the typeface selected and by the layout of the lines of type on the page (Tinker, 1963). Bouma (1971) demonstrated that individual lower case letters were better described and recognized in terms of their overall configurations (*e* is circular/*v* wedge-shaped) rather than in terms of their component features. Most contemporary research on letter identification through component features has been conducted with uppercase letters which perform better when presented individually in recognition tasks. It is well known, however, that *words* presented in uppercase letters are more difficult to recognize because of their relatively uniform contours. Words presented in lowercase letters are more easily identified because the ascenders and descenders produce more distinctive word contours facilitating reading through word-feature analysis (Coltheart and Freeman, 1974). This explanation fails to consider linguistic influences on word identification. For example, Kolers (1970) research demonstrated that the beginning, middle and end of a word do not contribute equally to word recognition. He found that the beginning of a word conveys more information, but due to linguistic rather than visual factors.

Children should be exposed to both upper and lower case letterforms when learning to read, but since the overall configurations of lowercase letters are more distinct, and perform better in terms of recognition in letter strings, they are more appropriate for beginning reading instructional material.

Beginning readers often confuse letterforms and their orientation because of certain visual characteristics many letterforms have in common. Direct instruction, differentiating between *visually* confusable letterforms such as *m/n, v/w, f/t, b/d and p/q,* with materials that **enhance and cue visual difference and correct orientation**, might be helpful in overcoming reading and spelling errors which can be attributed to a lack of attention to visual detail.

The most conservative description of **word recognition** is that it is a product of successive stages of analysis beginning with letter features followed by whole letters, then morphemic segments and finally whole words. This description does not consider peripheral factors such as word length, a component of global word shape, that functions as a separate cue in word recognition (Bouma, 1973). There is little agreement in the research literature as to what the visual features or cues used in letter and word recognition might be.

Reich and Cherry (1979) studied the effect of non-linguistic cues (like a change in the size of words as congruent or incongruent with the meaning of the sentence) on the comprehension of printed sentences and concluded that there was potential for non-linguistic cues for the performance of verbal tasks and that the adherence to conventional typography does not make use of **graphic support of information meaning in text** in addition to linguistic information.

Research has demonstrated that the use of **visual organizational principles such as chunking, hierarchical structuring, spatial segmentation** in relation to text content can improve comprehension and significantly aid recall (Hartley, 1978). Typographic and graphic (visual/spatial) cues should be used to advantage where possible, but care should be taken not to disrupt letter forms or the flow of word or line configurations.

Cognitive considerations: memory and learning strategies

The efficient reader uses only a few cues at a time. Visual cues are used when syntax and semantics fail to provide enough information for words to be read, that is, the child anticipates grammar and meaning and *then* glances at word parts to search memory for similar spellings or letter clusters or words according to sound patterns in language (Massaro and Klitzke, 1977). Words are anticipated based on semantics or meaning cues, syntactics or grammar cues and graphics or visual form cues.

Dyslexic children find it extremely difficult to anticipate grammar and meaning in sentences, they must first master phonological decoding and recoding to allow them access to these cues used by efficient readers. These coding processes involve the storage and retrieval of linguistic information in memory through the use of language mediation and subvocal rehearsal.

There are two distinct problems in the conservation of memory: first, mnemonic retention, which leads to decoding and retrieval, and second, the conservation of the codes or the schemata used to organize the material.

The use of **mnemonic devices** (techniques for using associations to aid memory) like **classification, rhyming, or anchoring and integrating text content with striking or humorous illustrative material**, can make learning material both motivational *and* memorable.

According to Haber (1970) memory for images is superior to memory for linguistic material. This was demonstrated in an experiment in which subjects were able to recall 85 to 95 percent of 2,560 slides that they had viewed previously. Haber's research suggests the possibility that **connecting images to linguistic material** may effectively improve the recall of both. Standing (1973) obtained similar results with a show of 10,000 slides. These findings suggest that images may aid retention, reinforce content, attract, direct and maintain attention for (and interest in) meaningful linguistic material providing the visual relationships between the images and print are strong.

The use of **visual and verbal schemata** (knowledge structures that indicate typical relations among components) in the presentation of learning material can help the child organize new information during encoding into memory. Schemata are flexible enough to tolerate considerable variation in content, but they should use **unifying concepts that have the greatest possible "generalizability" and explanatory power.** They should be programmed

in a manner that reveals the logic behind the underlying structure, and should be presented in a sequence that is optimal for the subject matter being studied. According to Ausubel (1978):

> When adequately inclusive context is available new ideas can be assimilated into cognitive structures much more efficaciously, thereby, facilitating both comprehension and retention of new material.

Since dyslexic children *are* able to recall images and use visual cues effectively, **meaningful images and visual form cues** that are related to concepts with associative connections to the child's experience of the world, that help broaden that experience, **should be used to help organize, schematize and reinforce the linguistic information** that dyslexic children find it difficult to store in and retrieve from memory.

Provision of focus for form and content

The proposed form and content of the instructional materials for dyslexic children address the specific difficulties with prereading and beginning reading skills previously outlined. In order to make the form and content of the materials as pertinent and manageable as possible, some dimensions to consider, with regard to their aural and visual perceptual features, precede the descriptions of the proposed materials.

Reduced stimulus complexity

The perceptual features of the task material are important because children will rely heavily on the perceptual characteristics of the material in the beginning. Their attention can become overloaded if they have to attend to more than three or four items or ideas at a time. The number of items presented in any given task should be carefully considered and limited (Roth Smith, 1983).

Unit size for introduction of new items

Bryant (1980) found that temporarily dropping learned items from lists of new items reduced response competition and facilitated mastery. The research suggests that optimal unit size for instruction may be a list of five words for reading and three for spelling.

Perceptual units in aural language

Sound patterns of *vowel, consonant/vowel or vowel/consonant* size are the best candidates for perceptual units since they can be described by fairly stable acoustical features (Fujimura, 1975).

Perceptual units in visual language

> Printed letters of a given typeface, defined in terms of their visual characteristics, are reasonable candidates for perceptual units at the primary recognition stage of reading; small groups or clusters of letters are suitable for beginning reading even though words, not graphemes, morphemes or syllables, are the characteristic psycholinguistic unit due to their "meaningfulness" as wholes (Bouma, 1973).

The proposed materials use various strategies detailed in section 1.3 to meet the objectives outlined. Through the typographic presentation of language, the materials aim to facilitate the learning of fundamental prereading and beginning reading skills by dyslexic children. The materials are organized into two groups according to the main phases of early reading instruction. **Descriptions** of form and content **are followed by the numbers** that identify the issues **in the objectives/strategies tree** that can be effectively addressed through typographic and graphic design (see pages 30-32).

Materials proposed for phase 1: *prereading or reading readiness*

The materials proposed for this first phase of instruction can aid the teacher or parent in addressing these primary prereading or reading readiness skills:

To be mastered by Kindergarten to Grade 1
• shape, direction, picture and letter identification • horizontal, vertical and symmetrical form discrimination • diagonal, asymmetrical form and mirror image discrimination • discrimination of overall configuration and internal features and details • awareness of upper and lower case differences • colour matching • verbal expression/listening skills • visual/motor coordination • word function (print/object relations) awareness • ability to follow instructions and • understanding of concepts/experiential background

Proposed are manipulable **tiles** (1.12/1.14) with black, graphically enhanced and cued letters from a Humanist font (3.12) on a white ground, intended to help children learn upper and lowercase letter matching (3.11), letter orientation and letter identification (3.15) (**appendix 11a-d**).

On the reverse of the letter tiles are coloured illustrations of objects (1.11/3.13/3.14/3.32/3.35). Object names with appropriate initial letters appear in print below the illustrations (2.11a/e/h). Initial letters of the object names are emphasized graphically (3.21/3.22/3.23/2.24/3.25). The names of objects for the illustrations have been chosen from the *Dolch picture words* list (the 95 commonest nouns). In some cases nouns have been added or substituted so that they begin with the appropriate letters *and* suggest easily identifiable objects for the illustrations. The illustrations have a warm, "friendly" or slightly humorous quality (1.25).

Illustrations on the reverse sides of uppercase letter tiles are shown 15 percent larger than the matching illustrations on the reverse sides of lowercase letter tiles. The concepts "large and small" are used in relation to both letters and illustrations (3.31/3.34). Children can determine whether they have made an upper and lowercase *letter* match by turning the tiles over to see whether the *illustrations* match (1.13/1.15/1.23/3.31).

Individual letterforms, both upper and lowercase, have been placed on tiles that allow enough depth to accommodate ascenders and descenders comfortably. A grey bar has been added, along the bottom edge of each tile, to help children determine letter orientation (3.15/3.35). The widths of the tiles correspond to the widths of the letterforms allowing the letters to be handled and physically placed together to form words that have reasonably tight and regular letterspacing representing, as closely as possible, the appearance of words in print.

Aspects of form in some letters have been enhanced in an effort to facilitate identification. Where enhancements of forms *within* the letters may not be sufficient to enable the child to differentiate between the confusable letter pairs, additional cues have been added in red (3.15).

Confusable letter symbols

As mentioned, *all* upper and lower case letter pairs are considered confusable by children learning to read, with the possible exception of pairs where there are changes in size, but not in form (*Cc/Oo/Ss/Vv/Ww/Xx/Zz*). In an effort to make some of the more confusable forms more distinct, the following changes and additions have been made to letter pairs identified as confusable:

uppercase **I** (i) and lower case **l** (L)

As these letterforms are nearly identical, two horizontal crossbars (pseudoserifs) have been added to the uppercase I.

uppercase **C** and **G**

A horizontal stroke has been added to the straight vertical on the *G*.

uppercase **O** and **Q**

A red half circle, flat-side-down, toward the tail has been added in the centre of the counters of both the upper and lowercase *Qq's*.

uppercase **P** and **R**

The lower connection of the bowl to the vertical stroke of the uppercase *P* has been detached to draw attention to the lack of a downstroke which occurs in the uppercase *R*.

uppercase **M** and **W**

A small, red isosceles triangle, centered on the baseline below the centre angle of both upper and lowercase *Ww's*, has been added.

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uppercase and lowercase **W** and **V**

The same triangle described above serves to differentiate between these two letterforms and may act as a mnemonic device if introduced as a *wedge* rather than a triangle.

lowercase **m** and **n** plus **n** and **h**

A red half circle, flat side down, has been centered on the baseline between the vertical and diagonal strokes of the uppercase *N* and the two vertical strokes of the lowercase *n*. *Node* may serve as a mnemonic device.

lowercase **b** and **d**

A red dot has been added in the centre of the counters of both the upper and lowercase *Dd's*. The word *dot* may serve as a mnemonic device.

lowercase **p** and **q** plus **b** and **d**

The cues for *b's, d's, p's* and *q's* mentioned above serve to differentiate between these two letter forms.

lowercase **t** and **f**

The horizontal arm on the left side of the lowercase *f* has been eliminated to relate the lowercase to the uppercase *F* form. This also serves to differentiate the *Ff's* from the *Tt's* which both have arms extending to *both* sides of the vertical strokes.

lowercase **i** and **j**

The descenders of both the upper and lowercase *Jj's* have been extended slightly to make the curved terminals more evident.

diphthongs c**oi**n/b**oo**k/m**oo**n/h**ou**se

In addition to the complete set of upper and lowercase letters, tiles for four of the most common diphthongs are included (3.15). To increase the child's awareness of the phonemes made by these vowel pairs, they have been presented together on a single tile (2.11a). They have also been connected graphically; linked into a single symbol, by a rule that runs between the tops of the lowercase letters (2.11a/3.21/3.25/3.35).

The difference between the two *oo* sounds is distinguished graphically by the rule that connects the letters in the less prevalent sound — the short one in *book*. The resulting letter symbol resembles a pair of spectacles which may act as a mnemonic device for the sound in *look* (3.32). In the more prevalent long *oo* sound — the one in *moon* — the letters are left unaltered (**appendix 11c**).

consonant blends **ch**eese/**sh**eep/**th**ere/**th**read/**wh**ale/stri**ng**

Tiles for the six most common consonant blends are also included to familiarize the child with their sounds (3.21). The consonants are presented in pairs, on single tiles, to emphasize the fact that they "make their sounds together." They are left formally unaltered with the exception of the two

th sounds. As above, a rule connects the letters in the less prevalent sound — the one in ***there*** — joining the horizontal stroke of the *t* to the vertical stroke of the *h* (2.11a/3.21/3.25/3.35). The phrase "*see t and h together **there***" may act as a mnemonic device (3.32). The letters in the more prevalent sound — the one in ***thread*** — are left unaltered (**appendix 11b**).

Materials proposed for phase 2: beginning reading

The materials proposed for this phase of instruction can aid the teacher or parent in addressing and consolidating these primary beginning reading skills:

To be mastered by Grade 2:
• familiarity with letter names • auditory/visual perceptual development (word matching/auditory matching/identification of rhyming words) • listening/language development • concept/background improvement • development of a sight vocabulary • discrimination of initial/medial/final consonants • discrimination of consonants, double consonants, digraphs, blends, syllables • ability to use context and picture cues for meaning • verbally complete incomplete sentences with context words • ability to read orally providing appropriate pitch and stress • awareness of speech /print relations • grammatical structural relations/plurals/inflectional variations • ability to follow story sequences • experience with books

Proposed are manipulable **cards** with black words, and coloured graphic decoding cues, on a white ground (3.21/3.25) (**appendix 11e**). To help children learn decoding skills *and* develop a sight word vocabulary, function words that rely on phonological coding to be read, have been chosen from the first half of the *Dolch Basic 220 Words (2.11a/b/c/d/f/g/i)*. The graphic identification of sound patterns may aid recognition and recall (3.25/3.35).

Graphic decoding cues

The visual cues that have been added to facilitate decoding consist of:

silent letter cues **tape wait**

Terminal e's that change medial vowel sounds, and other silent letters and letter groups are presented in grey, rather than black, to indicate that they are part of the wordform, but are not to be pronounced.

chunking cues **bl|a|ck tr|ee**

Vertical rules in grey that visually "chunk" words into component parts like initial consonants and blends, medial vowels and consonants, final consonants and blends, diphthongs and digraphs are added to render visible the structural patterns in single and multiplesyllable words.

long vowel sound cues **li̲ke re̲ad**

Long vowels, which are more difficult to learn and come later in the instructional sequence, are underlined in grey to identify them and to distinguish them, visually, from short vowels.

diphthongs and consonant blend cues l**oo**k c**oi**n **th**ere

Diphthongs and consonant blends that are graphically connected on the tiles appear the same way in the cards in order to help transfer the knowledge gained about these sounds.

soft and hard sound cues **c**ircus **g**iant

The soft *c* sound is indicated by a small grey circle placed in its centre. The soft *g* sound is indicated by a solid grey dot located in its counter.

primary and secondary stress cues **just**'ify'

Primary and secondary accents are indicated with black rules that run along the bottom of the cards. The portion of the word with the primary accent is underlinined with a heavy rule. The portion of the word with the secondary accent is underlined with a rule of about half the thickness of the primary accent rule.

syllabification cues **to|geth|er**

Syllables, in polysyllabic words, are rendered visible through the use of grey, vertical rules like those previously used to "chunk" single syllable words.

attention cues **mat** **ma**te **queen** **vision**

Sounds of individual letters or letter groups, that should be particularly attended to during instruction, are emphasized by a red bar along the bottom of the cards directly below them.

The width of the cards corresponds to the longest of the function words from the source mentioned. Their depth corresponds to the depth of the letter tiles allowing the child to handle and physically place the letters on or near the word cards to demonstrate awareness of letter, word and sound matching (1.12/1.13/1.14/2.11f/i). Content words may be spelled with the letter tiles and may be decoded as are the function words (**appendix 11e**).

Confusable letter sounds

Cards including words with the most commonly confused sounds identified below, are included in the set. The aurally confusable letters appear in a heavier weight putting visual emphasis both on the structure of the letterform and on its sound (2.11a/b/i/3.21/3.25).

bat and **p**at
cap and **g**ap
fan and **v**an
met and **n**et
tip and **d**ip
chip and **sh**ip
quiz and **wh**iz

These are only the main letter sounds that are troublesome for dyslexic beginning readers. There are many more examples of confusable sounds in *digraphs/blends/vowel sounds* and *endings* in Miles and Miles (1975).

A second group of cards, or rather **pages** that together form a book, is proposed for the stage of decoding that goes beyond single syllable words into whole phrases or sentences (2.11) (**appendix 11f**). These cards use illustrative material to provide context and picture cues for meaning (1.11), and include typographically cued text to facilitate oral reading through visual indications of pause and stress in addition to punctuation (3.25/3.35). Pages dealing with different content are colour coded according to content for easy identification and sorting (3.34).

By the time children reach this stage of reading skill, the cues that aid letter identification and basic decoding should no longer be necessary and have, therefore, been eliminated from the material. In the case of some unfamiliar words, long vowel sounds are cued.

The textual material uses primarily the *Dolch Basic 220 Words* and *95 Commonest Nouns* and emphasizes sound and spelling patterns through the use of rhythmic, rhyming text (1.13). Whole sentences are chunked spatially according to the rhyme scheme in the material and continuous text lines are broken, at logical points, according to meaning (3.13). Breaking longer phrases into shorter segments makes decoding them more manageable and visually indicates the pauses and rhythms that help make the text comprehensible (2.11a/b/c/e/i/3.22). Particular words or word parts that should be attended to are presented in a heavier weight than the remaining text for emphasis (3.15).

A strong structural and semantic relationship between text and image in the layout reinforces meaningful and humorous content. The illustrative material is intended to entertain and motivate the child to attend to the page and to the reading task (1.13). Ladan and Frascara (1977) after surveying the visual variables that influenced children's picture preferences cross-culturally found that pre-school to grade 3 children preferred realistic to geometric form (Harris, Schaller and Mitler, 1970), realism is generally preferred to abstraction (Lam, 1969; Levie, 1973), reduction of visual detail seems to enhance learning (Daves, 1975), but may have the opposite effect on preference (Stewig, 1975). Childrens' preference for complex illustrations may be age related and may depend on visual/organizational ability which undergoes rapid development in children aged from 5 to 10 years (Levie, 1973). Developmental limitations may heavily influence children's preferences for simpler or more complex images.

The illustrative material for use on the letter tiles and pages has been developed according to the above considerations. The comical character, *Amos the Aardvark*, has been developed with these and several other factors in mind (1.25). The Aardvark is a small, unthreatening and rather unusual animal with the vaguely monster-like qualities that seem to be so appealing to small children (1.11/1.22). The character has been given the identity of a male, because most of the children using the materials will likely be male, and has been endowed with child-like qualities to allow male and female children to identify with him (Krailing, 1988). He is also shown in "adult" contexts to allow them to explore some aspects of the adult world with which they may not yet be familiar. An effort has been made to show the character in a wide variety of situations and activities which are not gender biased (1.13).

Patterns are important to children under seven years of age, so that rhythm, rhyme, repetition, the choice of words and their arrangement on the page are of significance (1.23). According to Krailing (1988) children find rhymes satisfying and reassuring patterns in speech and that quirky rhymes about a fictional world that is safe, friendly and comforting are generally very well received.

The areas of instruction that should be especially helpful to children with dyslexia and other beginning reading difficulties have been dealt with in the proposed book pages (1.13) according to the content guidelines mentioned above (**appendix 11f**).

- vowel sounds (long and short)
- homophones (bear and bare)
- homonyms (te̲ar and tea̲r)
- alphabetical order (sequencing)
- confusable letter sounds (pairs)
- synonyms (big/huge/large)
- antonyms (front and back)
- classification (grouping)

2.2 Design development and production processes

Decisions for the design development of the proposed product are based on the criteria for form and content outlined in section 2.1. Production processes for the prototype developed were chosen according to availability, access and economy.

Selection of design components

The design components chosen should not compromise or substantially change existing letter, word or text forms, but should augment their distinctive features to facilitate visual and phonological identification and decoding to allow assimilation of content. Added visual cues *should* be removable, without the need for a fade-out period, to allow maximum transfer of gains made.

Typeface and fonts

Selected on the basis of several advantages they have over countless other fonts that might be suitable for the purpose, the letterforms of the *Stone Sans* family of fonts are simple, bold in form, and easily identifiable. They lack the formal complexities of serif fonts (especially evident in larger point sizes) which are so often used for beginning readers. The large *x-height* and open inter and intra letter spacing make *Stone Sans* extremely legible and readable. Classified as one of the fonts belonging to *sans serif/humanist* families of type, *Stone Sans* letterforms have an unaggressive character and appear less mechanical than some of the more geometrically constructed alternative sans serif typefaces. Formally, the sans serif/humanist fonts are based on the proportions of Roman inscriptional capitals and old style lower case letters. They exhibit characteristic contrasts in stroke weight and have the advantage of relating structurally to both *serif* and *sans serif* fonts which may facilitate letter identification in various typestyles. *Stone* has the additional advantage of several clearly distinguishable weights that can be used for emphasis. Slanted terminals on letters with oblique strokes make them easier to differentiate from eachother than letters with horizontal terminals on oblique strokes as can be seen in the following sample of letters from three different typefaces.

vwxy	vwxy	vwxy
Palatino Medium Roman	**Avant Garde Meduim**	**Stone Sans Medium Roman**
serif/old style/aldine	sans serif/geometric	sans serif/humanist

Typeweight

Although *Stone Sans* is available in a variety of fontweights, in an effort to make visual emphases through distinctions between weights as simple, clear and evident as possible, only Medium Roman and **Bold Roman** are used.

Typesize

Design components involving individual letters and letter groups within words are set in 72 point *Stone Sans* which is large enough to allow the formal features of the letterforms to be seen, but not so large that, when letters are placed together to form a word, the entire word form is difficult to perceive as a unit. Continuous text is set in 18 point *Stone Sans* which is large enough to allow individual letterforms to be seen while easily allowing wordforms to be perceived in small groups.

Colour scheme

Colour is used primarily for visual attraction. Functional or operational cues cannot be dependent on colour since approximately 8.5 per cent of males and 0.5 per cent of females are colourblind to some extent (Hartley, 1978).

Letters on tiles, cards and in text appear in black on white to correspond to print. Silent letters in words on cards, and some other visual cues, appear in grey. The shift in tonal value from black to grey is substantial enough that discriminating between them should not pose a problem to colourblind children. Graphic cues for aspects of recognition or identification requiring a high degree of attention appear in red. For colourblind children the presence of these additional forms alone will direct their attention to the pertinent aspects of the task. Bands of colour identify text pages, in groups, acccording to content. Colour may be useful as a motivational device — having mastered one colour group a child may be delighted to proceed to the next group or to choose which colour group to work with.

According to Porter (1974) 7-9 year old children's colour preferences ranked as follows: blue/red/green/violet/yellow/orange (cited in Krailing, 1988). An effort has been made to restrict the colour palette for graphic cues and illustrative material, to these primary and secondary colours with the addition of black and shades of grey.

Format

The proposed visual communications are realized in a format that is functional, portable and relatively economical to produce, with a size that is accessible and a visual appearance that is attractive to children.

Three-dimensional, manipulable letter tiles and word cards with graphic cues to aid in matching, decoding and spelling tasks are included. Individual letterforms, both upper and lowercase, are placed on **tiles.** Content and function words appear on **cards** that correspond to the letter tiles in the size of letterforms and the vertical dimension (depth) of tiles and cards. This allows the identification of letters in words and spelling comparisons to be made directly. Text is supported by illustrative material that reinforces content and presents it, sequentially, according to complexity. Content presented on **pages**, that together form a **book**. The pages can be used individually, as "cue cards" in instructional situations.

The tiles, cards and book are stored in a bright, moulded plastic school case that is available commercially. Small and light enough for small children to carry between home and school, it is inexpensive and provides ample storage space for tiles, cards and book.

Graphic elements to aid recognition

Graphic elements that help distinguish confusable letterforms from each other are added in the form of **point** elements. These elements do not disrupt or invade the original letterforms and are placed so that they are clearly distinguishable from the letterforms spatially and through a change in colour.

Line or rule elements divide, connect or "chunk" pictorial or verbal elements within the layout. Vertical rules are used to segment words on cards without having to interrupt the word form spatially. Horizontal rules provide visual connections and divisions between pictorial and verbal elements on book pages, indicate stresses or accents on words cards and cue orientation of illustrations and letterforms on letter tiles.

Illustrative material

Bearing in mind the visual variables outlined that influence children's picture preferences, illustrative material uses geometric forms with aspects of realism. Image complexity is reduced to enhance learning.

Simple drawings with enough visual detail, and variation in layout, to provide content, context, support for meaningful material, and of course interest and attention, are used.

Textual material

Meaningful text content deals with themes of related objects or concepts. The majority of the content is semantically familiar to what is already in the child's conceptual system. Textual material is, at times, problem oriented to test listening and analytical skills and has direct instructions built in to encourage involvement and active verbal responses.

A rhythmic rhyming text deals with various phonological aspects of language, while fostering a playful, relaxed atmosphere for learning. Humorous text content further alleviates stress.

Word cards and pages make use of the *Dolch picture words* or the 95 commonest nouns and the *Dolch basic 220 words.* The latter are short, high-frequency words (mostly function words) that must be decoded phonetically and contain 75% of all words used in first grade reading and 65% of the words used in other primary books.

The areas that should be dealt with in the proposed book pages are grouped according to their content (colour is used for visual interest).

- short vowel sounds **green**
- homophones **blue**
- homonyms **red**
- alphabetical order **orange**
- confusable letter sounds **yellow**
- synonyms **purple**
- antonyms **aqua**
- classification **lime**

Layout

The layout of design components is simple and systematic in order to minimize confusion, but has enough variety to be stimulating. Visual and verbal elements that are intended to be perceived as units are defined according to certain gestalt organizational principles:

proximity: visual and verbal elements placed close together are perceived as groups
similarity: visual and verbal elements are linked through the use of similar size, shape, direction, colour, value, etc.

All design components, verbal and pictorial, have been selected in order to present graphic language and illustrative material to beginning readers in the clearest, most functional and attractive manner possible. The components chosen should allow the instructional objectives to be met effectively.

Production and reproduction processes

All typographic material was designed, layed out and produced on an *Apple Macintosh SE* computer with *LaserWriter Plus* output. Some coloured graphic material was added in the form of *Pantone Letrafilm Matte* and *Chromatech* dry transfer lettering.

Original illustrative material was produced through watercolour painting and felt marker drawing techniques and reproduced on a *Canon Colour-Laser Copier*.

Letters and illustrations for letter tiles and words for word cards were drymounted on to heavy-weight *Frisk* board and hand-cut. Colour copies of the pages were drymounted on to single weight *Mayfair* stock and bound.

All material for final use would be printed in process colour with the exception of the word cards which would be printed in three colours. All materials should be laminated or otherwise protected to allow the tiles, cards and pages to be wiped with a damp cloth when necessary.

2.3 Use of the product developed for instruction

The elements of the product developed may be used by the teacher or parent in any manner appropriate to all phases of prereading and beginning reading instruction. Some suggestions and guidelines for product use are given below.

Development of activity strategy and structure

Ideally, the teacher or parent should **develop an individualized program of instruction** using the proposed visual communications while capitalizing on the individual child's strengths and intelligence (1.32) and breaking down the content of the task that is troublesome into easier steps (1.33). The instructor should note which steps the child has mastered before the introduction of the next more difficult step (1.24).

Sperry (1974) lists useful **dimensions to consider** when analyzing tasks from least to most difficult:

internal to external communication skills: expressive skills are more difficult than receptive skills

non-social to social learning situation: group work is more difficult than individual work

concrete to abstract learning material and responses: pairing a word with an action is more difficult than pairing it with a picture representing its meaning

non-verbal to verbal materials and responses: language tasks are more difficult than visual and motor tasks (ie. matching word shapes is easy, but applying language to a "visual symbol sequence" is difficult)

the most difficult task: conjuring up the language and visual symbols from memory and writing them down

non-symbolic to symbolic language: understanding language when translated into another symbol system (letters) is often more difficult than understanding the same content in oral speech

static to sequential items and responses: dealing with elements in a series is more difficult than dealing with each one in isolation

short-term to long-term recall: recalling items after a time is more difficult than shortly after presentation

Prereading instruction strategies

It is important to focus attention (1.11/1.12/1.13/1.14/1.15), explain tasks (1.22), concentrate on naming (2.11h), point out pertinent details both visual and aural (3.33), present material in a systematic sequence or cluster of steps (1.23) and build self-esteem and confidence through praise and encouragement allowing the child to experience success (1.31/1.34/1.35).

The child's attention should be focused on the prereading task, through the physical manipulation of the **letter tiles**. Activities may be determined for individual children or children in small groups in order to teach them to working cooperatively; for example one child may be "assigned" a matching task, but other children in the group may "help" find the match. The following are suggestions of **tasks to improve prereading skills**:

letterform identification *tiles*

Children may be asked to find and name certain upper and lowercase letters making use of orientation cues. If the letter cannot be identified, the picture cue on the reverse of the tile may be used to help the child retrieve the letter sound and, as a result, the letter name. Confusable letter symbols should be presented together during instruction with visual form comparisons made directly and cues to facilitate letter identification pointed out. When letters are identified reliably, the additional forms should be removed.

letter sound identification *tiles/cards/pages*

Children may be asked to identify letter sounds prompted by upper or lowercase characters. If the letter sound cannot be determined, naming the picture cue on the reverse of the tile may help the child retrieve the letter sound. Confusable letter sounds should be presented together during instruction with aural comparisons made directly and cues to facilitate letter identification pointed out. When the letter sounds are identified reliably, the graphic cues should be removed.

upper and lowercase letter matching *tiles*

Children should be asked to match uppercase letters with lowercase letters. They can determine, by themselves, whether upper and lowercase *letters* match by turning the tiles over to see whether the *illustrations* match. If the letter match cannot be determined, the child may use the picture cues on the reverse of the tiles to help match the upper and lowercase letterforms.

picture matching / size discrimination *tiles*

The instructor may ask children to match the "big and small" picture cues on the reverse of the letter tiles.

object and colour naming *tiles*

Children may be asked to identify certain objects and to name the colours of those objects.

Beginning reading instruction strategies

It is important to work on long-term memory strategies. Beginning readers should be capable of:

- *a* *rehearsing aloud* (3.22/3.24)
- *b* *organizing into categories* (3.34)
- *c* *verbally elaborating to consolidate information in long-term memory* (3.23)
- *d* *clustering or chunking items to aid recall from long-term memory (3.31/3.32)*

The instructor should use content material, provide context information and teach the child to subvocalize and vocalize responses (3.22). The child should listen, make judgements, put the information to conceptual use (3.31) and respond verbally (1.14). The teacher/material should give positive reinforcement for correct responses (1.35) and redirect incorrect responses (1.34).

The child's attention should be focused on the beginning reading task, through the physical manipulation of the **letter tiles** and **word cards**. Again, activities may be determined for individual children or children working in small groups. The following are suggestions of **tasks to improve beginning reading skills**:

classification *tiles*

Children may be asked to find all the pictures of objects on the tiles that share certain characteristics in order to engage them in a sorting or classification task (ie. find all the animals/things you can eat/things you can wear, find all the red things/big things/small things, etc.).

alphabetical order *tiles*

The instructor may ask children to place all the tiles picture-side-up and to put the objects in alphabetical order using the object names. Order can be checked by turning the tiles over to see whether they have put the letters of the alphabet in order by reciting the alphabet.

memory *tiles*

After placing all the tiles picture-side-up, the instructor may select three, five or more tiles (according to ability levels of the children) and ask them to try to remember the pictures. The instructor gives the children a few seconds to look at the picture cues then gathers the tiles and turns them letter-side-up. Children are then asked to name all the pictures they can remember using the letters as mnemonic cues if necessary. As children become proficient at this memory activity, the number of tiles may be increased and the tiles hidden while the children respond.

word decoding and matching *tiles/cards*

Children should be presented with single-syllable word cards, one at a time, and instructed to select the letter tiles that match the letters on the word cards and to place them in the proper sequence. They should be asked to decode the sounds (according to letter clusters or graphemic patterns) *in chunks.* Tiles may be grouped or separated spatially, while decoding, according to the divisions on the cards that render graphemic patterns visible. When the sounds have been blended successfully, the tiles may be pushed together to indicate the visual and aural relationships between the chunks. Aural difference between confusable letter sounds or clusters should be emphasized. If the child is unable to differentiate between letter sounds, appropriate repetition and reinforcement of rhyming word pairs containing confusable letter sounds, on cards or pages, should be presented and mirrored with tiles until the sounds are identified reliably. Children should be shown that some letter sounds are cued graphically, that words containing two or more syllables are segmented according to syllabic breaks and that their primary and secondary accents are indicated.

word encoding *tiles*

The instructor may select both content and function words with three or more letters (according to ability levels of children), pick out the letters in the word, place them randomly on the table and ask children either to spell a specific word or simply to try to "make a word" out of those letters.

rhyming word identification *tiles/pages*

Children may be asked to consider a word of three or more letters that the instructor has spelled with the tiles. They should then be instructed to substitute or add one or two letter tiles to make a "new word" that rhymes with the original word. The repeated patterns in the words that "make the rhyme" should be pointed out directly. Children may be asked to listen carefully for two words that rhyme while the instructor reads the text on the pages. The words can then be spelled by the child and the aural comparison of the similar or confusable sounds can be made.

long and short vowel sound identification and silent e *tiles/pages*

Pages with rhymes containing long and short vowel word pairs should be used, with tiles, to explain the vowel sounds and the effect of the silent terminal *e* on a short medial vowel. The tiles should be used to spell a word with a short medial vowel, then the terminal *e* should be added and the sound change explained.

use of context/picture cues for meaning   *tiles/pages*

homonyms: the instructor should use the appropriate tiles to spell the word with the children. The instructor should then read the text emphasizing the key words and point out the way in which context helps determine the different pronunciation of each of the words using picture content to reinforce the concept.

homophones: the instructor should use the appropriate tiles to spell the two words with the children. The instructor should then read the text emphasizing the two key words. Children should be instructed that the pronunciation of the words is identical, but that context clues, in the pictures and in the text, can help them determine the different spellings of each of the words.

synonyms: the instructor should read the text and point out to the child that there are words in the rhyme that mean the same thing. The child may be asked to identify those words in the text or may be asked to name another word that means the same thing. Children may use the tiles to spell the words. Pictures may be used to stimulate discussion about the concepts involved.

antonyms: the instructor should read the text and point out to the child that there is a word in the rhyme that means the opposite of another word. The child may be asked to identify those words in the text. Children may use the tiles to spell the words. Pictures may be used to stimulate discussion about the concepts involved.

The activities and strategies mentioned here detail only a few of the uses of these materials. It is hoped that the components of the product, and the relationships between them, are flexible enough to enable creative parents and classroom teachers to incorporate the materials into their own instructional or diagnostic activities and games.

3.0 Observation of the product in instructional situations

To take some initial steps toward evaluating the materials produced, an informal observation and analysis of their use in instructional situations is undertaken and the results considered with a view to refining the form and content of the pieces to prepare them for more rigorous testing.

Professionals in the fields of Educational Psychology, Special Education and Elementary Education were consulted during the development of the proposed instructional materials. They responded favorably to the form and content selected for the product prototypes, and approved of the concepts behind the design decisions made, but indicated some areas of concern. One instructor suggested that the enhanced letterforms and additional identification cues might be disturbing or distracting to the children. Several of the professionals were concerned that the physical size of the tiles and cards might be too small for the children to handle.

In order to make some preliminary judgements about the broader issues affecting the form and function of the materials, such as those mentioned above, field evaluation situations were sought where both the materials and the users could be observed during typical instruction sessions.

3.1 Assessment procedure

With the assistance of professionals in the fields mentioned above, the materials developed are placed with groups of children in three different educational environments so that a general assessment of the function and appeal of their verbal, visual and formal components can be made. The materials are placed in instructional situations that include male and female children, of different ages and backgrounds, with developmental lags. Instructors worked with them individually and in groups.

A case study

In order to see how the materials might function in an individualized instructional situation, the appropriate elements in the materials were integrated into the individualized tutorial sessions, within the public school system, of a small, seven year old boy, who we shall call "Tim."

Although Tim appears to be a bright and curious boy, he exhibits a developmental lag of about two years and has an unusual amount of difficulty with some prereading and beginning reading skills. He cannot spell his name when asked. He is able to select the letters in his name from a group of letters, but has trouble naming and sequencing them. He can reliably identify and name 14 letters of the alphabet including *a b c f i k l o p s v w x* and *z*, but has trouble identifying and naming *d e g h j m n q r t u* and *y*.

A remedial reading instructor works with Tim three days per week for about one hour per day. After three weeks of instruction, and a one week school break, the instructor was asked to introduce the lowercase letter tiles, to use them, when appropriate, for a three week period and to record the instructional sessions on a cassette tape.

Prior to the introduction of the tiles, the instructor had been teaching Tim to spell and read the words *yes* and *no* using lowercase magnetic letters made by *Fisher Price.* The magnetic letters are coloured, moulded plastic approximately four times the size of the letterforms on the tiles. The magnetic letterforms are virtually identical to the letterforms on the tiles with the exceptions of a/ɑ l/l i/i and q/q (magnetic letterforms shown last). Each upper and lowercase pair of magnetic letters is the same colour, but *several* letters in the alphabet share a colour, for example *Ff Nn* and *Uu* are all blue. The instructor mentioned that although Tim initially used the colours of the magnetic letters as cues for identification, he confused some of the different letters that shared a colour.

The information and observations that follow are taken from the tape-recorded sessions and from conversations with the instructor. On the first day using the "new" letters (tiles), the instructor asked Tim to pick out the appropriate letters to spell the words *yes* and *no*. He responded very quickly and seemed to have no difficulty in transferring his knowledge of letter forms from the three-dimensional magnetic letter forms to the two-dimensional letterforms on the tiles. She explained to him that the "little grey lines" along the bottom of the tiles were to help him "not to get any letters upside-down." He seemed unaware of these orientation cues with letters that were familiar to him, but several sessions later, when some unfamiliar letters were introduced, he was able to recall that the grey lines went at the bottom and was able to use them as orientation cues.

Since most of the letters that were familiar to Tim were not confusable with each other, but rather with the letters that were unfamiliar, the cues to aid in the differentiation of confusable letterforms did not come into play. Tim seemed to be able to identify the familiar letterforms without difficulty and did not seem to be disturbed by the additional identification cues or by the slight alterations in form of the enhanced letters.

When the unfamiliar letters *y e* and *n* were introduced in the process of learning to spell the words *yes* and *no*, the instructor explained to Tim that if he was unable to recall the name or the sound of a letter, there was "a clue" for him on the back of the tile — "a picture of something beginning with that letter." He identified *n* for *nurse* and *e* for *eggs*, but could not identify *y* calling it *x*, likely due to the crossing diagonals. Tim did not understand the picture cue for *y* (*yoyo)* and was given an explanation. When shown the *y* tile the following week, although he was still unable to name the letter,

he recalled the picture cue and called out "yoyo!" This seemed to boost his morale — the instructor used the positive mood to introduce other words beginning with *y* in order to reinforce the learning of the letter name.

Tim's instructor proceeded to show him picture cues from both the familiar and unfamiliar letter groups. Most consonants and their picture cues from both groups were named without difficulty. He had some trouble identifying the picture cue x-*ray* and sometimes confused the letter *k* with *x* and *y*, but was able to name *k* correctly after using the picture cue *(key)*. He found it difficult to name the vowels even when he could name their picture cues. He identified the lowercase a̲ without using its picture cue *(apple)* even though the form was quite different from the magnetic letters he had learned with originally (ɑ). Naming *e* seemed to be especially difficult for Tim. He identified the picture cue for *e* (*eggs*) with ease, but could not retrieve the letter name. He could name the letter *i*, but had trouble identifying the picture cue (a bottle of *ink)* which he called *medicine*. He identified the letter *o*, but although he was able to name the picture cue *(owl)*, he had trouble deriving the sound from it.

To ensure that Tim's learning environment was extended to include his home, his mother had been asked by his instructor to help him prepare a simple sentence to bring to school each week in order to work on reading, writing and spelling the words in it. The first three weeks of instruction he came with a sentence, but the fourth week he came without one. When asked why he didn't have a sentence, he replied that when he had asked his mother for one she had said she didn't have time to prepare one with him. Evident in his performance, and his tone of voice on the tape that day, was the fact that Tim had to cope not only with his frustrated efforts at learning to read, but also with the disappointment and embarrassment in his mother's lack of involvement and moral support.

On completion of the evaluation period, the instructor returned the letter tiles with some written observations about their form and content. She suggested that the advantage of the tiles over the coloured magnetic letters was that because all the letters on the tiles were black, it forced Tim to observe and rely on the forms alone to help him identify letters. Although she initially felt that the tiles might be too small, she discovered, while watching him at work, that the size of the tiles seemed "just about ideal" for his small fingers and hands.

As previously mentioned, the orientation cues appeared to work very well and the confusable letter identification cues, although they were not used, did not seem do disturb or confuse Tim. He seemed not to notice that some letterforms had been changed slightly; he identified them without any trouble. Tim's instructor expressed some concern about the names of the picture cues beginning with consonant blends, like *broom* and *grapes*, rather than single

consonants like *ball* or *goat*. She indicated that the picture cues *ink, up* and *x-ray* were difficult for Tim to name. For *nurse* she suggested *nuts* or *nail;* for *queen,* which Tim first called *king,* she suggested *quilt,* for *up — umbrella;* for *water walrus;* for *ink — ice cream* and for *x-ray — xylophone.* Decisions made regarding picture content and word length will be discussed in section 3.2.

A remedial readiness program

The letter tiles, word cards and pages were introduced to a group of six children involved in a reading readiness program within a hospital school system. All six children were boys between five and eight years of age who were developmentally delayed by two years or more. The materials were used in various instructional situation, determined by the classroom teacher, for short intervals during a four week period. The teacher and her assistant were asked to integrate the materials into their usual instructional sequence, as appropriate, and to observe and record their impressions about the children's reaction to and use of the materials.

At the end of the four week period, the teacher and her assistant reported that the boys "loved using" the materials and that they "seemed to use the picture and orientation clues 'naturally,' without any cueing." Although both the teacher and her assistant initially found the letter tiles to be too small, the boys said they found them "easy to handle" and liked the size when asked. In order to allow the effects of novelty to wear off, the boys were asked various questions about the materials *after* they had worked with them for a time. They all liked the illustrations on the tiles and found them easy to identify and name with the exception of *ink*. *Amos the Aardvark* character appeared to be well-received with both the younger and the older boys. They did not perceive the character as male or female, but rather as "Aardvark. " The teachers thought the drawings were easily identifiable and "had the right amount of complexity." They also mentioned that they found the "words" on all the materials to be "clear and legible."

The teacher and assistant found the format "unique and quite flexible" and adaptable to a number of instructional activities. Over the four week period the materials had been used for instructional and diagnostic activities and games. The teacher expressed a desire for a "manual" suggesting possible uses of the different materials and explaining the sound cues in detail.

A segregated resource class

The letter tiles, word cards and pages were introduced to a group of children involved in a segregated resource class within the public school system. The group of children varied in size from day to day and was made up of boys and girls, between the ages of six and thirteen, who had various degrees of

difficulty with reading skills. The materials were used for 15 to 20 minutes out of a daily half hour instructional session for a four week period.

The teacher, assisted by a student completing her teaching practicum, was asked to integrate the materials into the usual instructional sequence, as appropriate, and to observe and record her impressions of the children's reaction to and use of the materials.

Letter tiles were used primarily in letter naming and spelling tasks. The illustrations on the tiles were popular and well-accepted by the children including those in the older age group. *Amos the Aardvark* , which was aimed at younger children was well-received even by the thirteen-year-olds. The children did not seem to perceive strong age or gender associations in the character. The only common perception was that the character was "small" (meaning smaller that the children themselves). According to the teachers, the illustrations of objects on tiles were easily identified with the exceptions of *ink* and *x-ray*. They were concerned that the illustration size difference on upper and lowercase tiles might be overlooked by the children unless it was specifically pointed out. Letterforms were found to be generally clear and easily identifiable with the exception of the lowercase *f*. The tile and letter size was, in the estimation of the teacher and her colleagues, about 40 percent of what they felt they should be. The children appeared to have no difficulty with the size of the tiles.

The teacher felt that there was potential in the cueing system. She stressed the need for a manual with a master sound chart, to accompany the material, that would explain the cues in detail and give directions to the teacher about suggested uses for the materials.

3.2 Implications for design and content modifications

As a result of the children's reactions to the materials, the instructors' observations and the designer's insights, a few modifications were suggested during the course of the evaluation.

The picture cue for *e* (*eggs*), although easily identified, did not provide Tim with the long *e* sound he required in order to recall the letter name. Tim also had trouble deriving the appropriate sound from the picture cue for *o (owl)*, because the *o* sound is modified by the *w*. This suggests the need for a stronger aural relationship between object names and long vowel sounds which relate directly to the letter names of vowels. A set of five tiles with objects that begin with long vowel sounds, in addition to the existing tiles with short vowel sounds, might help children name these letters by facilitating the retrieval of the initial sound. The additional tiles would also be useful for later instruction dealing with long and short vowel sounds (see appendix 11d).

Children seemed to have trouble identifying the picture cues for *ink* and, in some cases, for *x-ray*. The picture cues were modified to make identification somewhat easier. One instructor suggested that words like *broom* or *grapes* that begin with consonant blends might be a problem because they are more complicated and are taught later in the instructional sequence, but if too many words are similar in length it might make them less distinct from each other and, therefore, more difficult for children to recall. Some suggestions for shorter, simpler words were taken into consideration, like *nail* for *nurse*, as were some suggestions for less confusable objects like *quilt* instead of *queen* which was sometimes called *king*, and *walrus* instead of *water* which was sometimes called *pour* or *bucket*. It was suggested that a tile for *oa* be added, as this diphthong is often troublesome to beginning readers, and that only the less prevalent diphthongs should have graphic connections for identification purposes.

There were complaints about the lowercase *f* "looking funny" because it was missing the horizontal stroke on the left side of the vertical stroke. The stroke, which had been removed in order to differentiate it from the lowercase *t* was restored. Oddly enough, there were no complaints about irregularity of the bottom of the bowls on the upper and lowercase *Pp's* being detached from the vertical strokes, but prompted by the *f* problem, all other letterforms were reexamined. In an effort to regularize them, the *Pp's* were both "connected" since that is how they are normally seen in print. There were suggestions that the identification cue to distinguish *n* from *u* was unnecessary since the orientation cue *bar* alone seemed to solve the problem, and the identification cue for *Qq* was changed to a *square* to act as more of a mnemonic device. Neither of these nor other additions and changes to letterforms were questioned by the children which may mean that they were not disturbing or confusing and were totally ignored or, conversely, that they were not disturbing or confusing and were used as intended: to help children distinguish confusable letterforms from each other without being intrusive. Rigorous testing would be required to determine which of these alternatives is the case.

There was little opportunity for the graphic decoding cues on the word cards to be used in the instructional situations where the evaluations took place, due to the children being in the early stages of the sequence of reading instruction. The only suggestion for a modification was that the cues for long vowel sounds appear *above* the letters, as in traditional pronunciation keys, rather than below the letters as indicated in the cueing system. Although the long vowel cues *below* the letters were intended to be less visually disruptive to the wordform, it is easy to see how they might cause confusion later in the instructional sequence when children learn to mark long and short vowels in the traditional manner. This suggested that the cues be changed to be consistent with traditional methods of indicating long vowel pronunciation.

4.0 Summary and recommendations

Based on the research undertaken, the product developed and the user response during the initial evaluation process, some recommendations are made regarding the potential of the proposed materials and implications for further investigation are discussed.

Considering the positive response of the instructors and the performance of the children participating in the evaluation of the proposed materials, there appears to be potential in the idea of using a system of graphic and typographic cues to help children learn prereading and beginning reading skills. Instructional content, sequences and approaches, developed by an interdisciplinary team of educators, psychologists and curriculum development specialists, would be rendered more effective through appropriate typographic and graphic presentations of visible language devised by visual communication designers.

Clearly, teaching prereading and beginning reading skills to children with developmental lags and limited language abilities, or to typical children, is not dependent on the design of the materials alone. The *quality* of instruction and the manner in which materials are *used* for instruction are critically important. The value of well-designed instructional materials lies in that they may simplify the acquisition of reading skills through their motivational power, their operational or functional facility and their flexibility and adaptability to a wide variety of remedial and prescriptive instructional tasks and objectives.

The results of the evaluation undertaken indicate that typographic and graphic design that renders visible the relationships between the aural and visual components of language in instructional material may facilitate beginning reading for dyslexic and typical children. Further investigation would be required to determine the effectiveness of specific cueing devices within the system of materials developed for this thesis project.

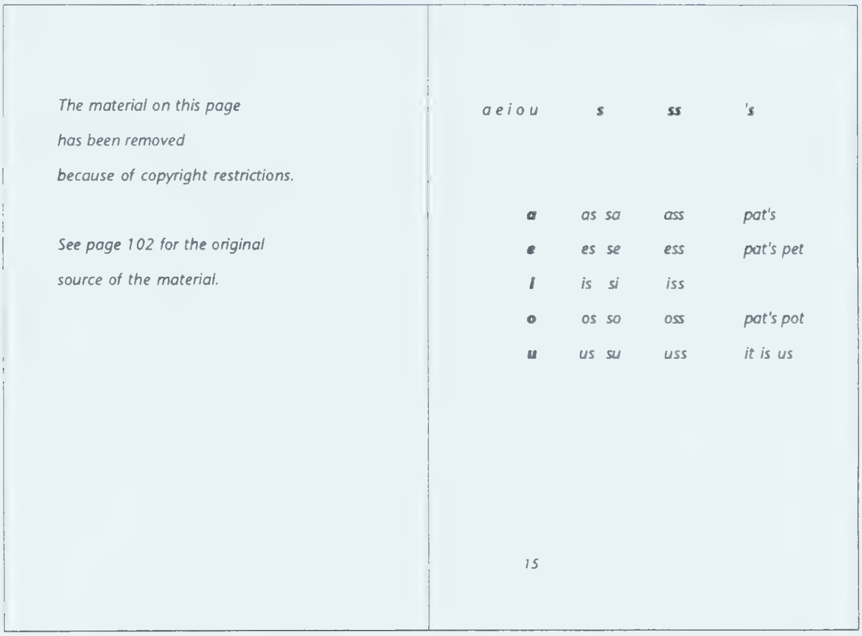
Appendices

Appendix 1

Visual Patterned Alphabet (VPA)
Designed to improve children's knowledge about the physical structure of letterforms, the VPA assists them with letter discrimination by providing letterforms with patterned backgrounds which enhance the distinctiveness of different letters and the similarities of the same letters, from different cases or fonts. This system deals effectively with prereading skills such as the relationship between individual letters, letter order, and letter direction and sequence, but does not teach letter sounds. Among the advantages of this system over some others is the direct transfer of the VPA letters to standard print and the economy of their production in black and white.

Appendix 2

Visual Communication Design
Master's Thesis Project



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See page 102 for the original source of the material.

a e i o u	*s*	*ss*	*'s*
a	*as sa*	*ass*	*pat's*
e	*es se*	*ess*	*pat's pet*
i	*is si*	*iss*	
o	*os so*	*oss*	*pat's pot*
u	*us su*	*uss*	*it is us*

15

Words in Color
Gattegno's system uses 47 colours to code sound. This is an example of a black and white printed page from one of the system's workbooks. In addition to the problem of the lack of colour cues in the booklet, the page shows no clearly established reading direction and related elements are not grouped in a logical and consistent manner.

Layout redesign
The layout of the same page was redesigned, by the author of this thesis, to establish clear groupings of related elements in order to facilitate visual search and the recognition of the important relationships between grouped elements.

Appendix 3

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See page 104 for the original source of the material.

Initial Teaching Alphabet or i/t/a

Developed by Sir James Pitman, each symbol in this 44 character alphabet represents a single speech sound. Spelling is determined by pronunciation. Problems arise, for children learning to read, when the shift from i/t/a to traditional orthography takes place.

Adaptation

*An adaptation of the initial teaching alphabet, to allow the use of normal lowercase type, was proposed by Edward Rondthaler. In his 24 character version **q** is replaced by **kw** and **x** by **ks.** In both the original and the adapted versions the uppercase letters were eliminated. (Spencer, 1968).*

Appendix 4

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*See **Roth Smith** page 104*
for the original
source of the material.

Peabody Rebus Reading Program
These examples illustrate the method used to link visual symbols with printed words. The symbols are often difficult to "read" because of the irregular and informal quality of the drawings.

Adaptation
The rebus idea adapted to letterforms is shown in this example. Although the illustrations may serve as mnemonic devices that help children recall the shapes of individual letterforms and their sounds, it is unlikely that they will teach sufficient phonic skills to enable children to decode unfamiliar words. The legibility of the letters has been compromised to strengthen the already tenuous relationships between the objects and letter shapes.

Appendix 5

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Multisensory Activities
Teaching reading with multisensory activities based on the notion that focusing a child's attention on the distinctive features of a task, involving all the senses in a learning activity, may facilitate learning (Borba and Ungaro, 1980). Dyslexic children would likely find these tasks tedious.

Layout redesign
*The layout of the teachers' workbook pages shown (below) was redesigned, by the author of this thesis, to organize, clarify and accommodate all the activities and information relating to one subject, in this case the letter **Aa**, on one spread (above).*

Appendix 6

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See page 102 for the original
source of the material.

The Fitzhugh Plus Program
Shape Matching / Shape Completion /
Shape Analysis and Sequencing

The abilities required to complete these tasks are not deficient in dyslexic children. There is little or no transfer of the skills necessary to perform these tasks to the skills necessary for efficient reading. None of these activities provides practice with letter or with word recognition.

Appendix 7

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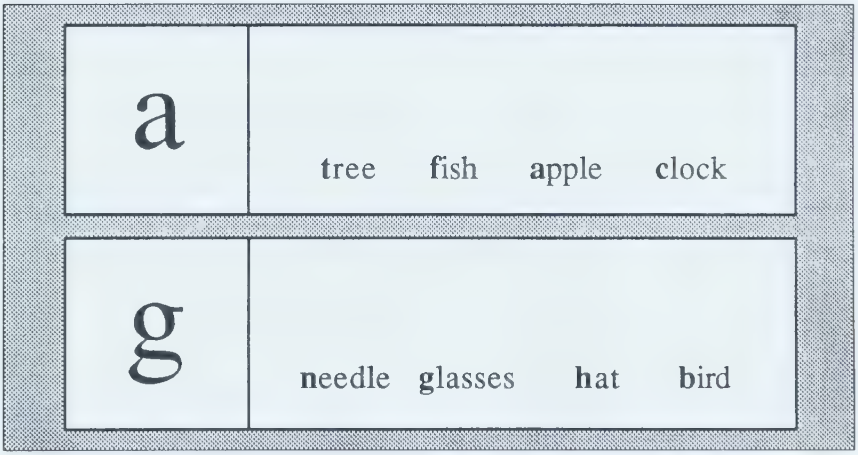
See page 102 for the original source of the material.



The Fitzhugh Plus Program
Alphabet and Common Nouns (above)

The alphabet recognition training task uses an overly obvious"cueing device." The noun recognition task is reinforced with picture/word association in which the picture, which is not meant to be of primary importance, is far stronger than the word. The stimulus letter is from a different font than the response cues used throughout the problems complicating the recognition task. The visual relationship between the two stimuli is stronger than the relationship between each stimulus and its corresponding response alternatives.

Redesign *(below)*
The information was restructured, by the author of this thesis, to facilitate the reading task. Lowercase letters are used to foster recognition of the letterforms when they appear in printed text.

Appendix 8

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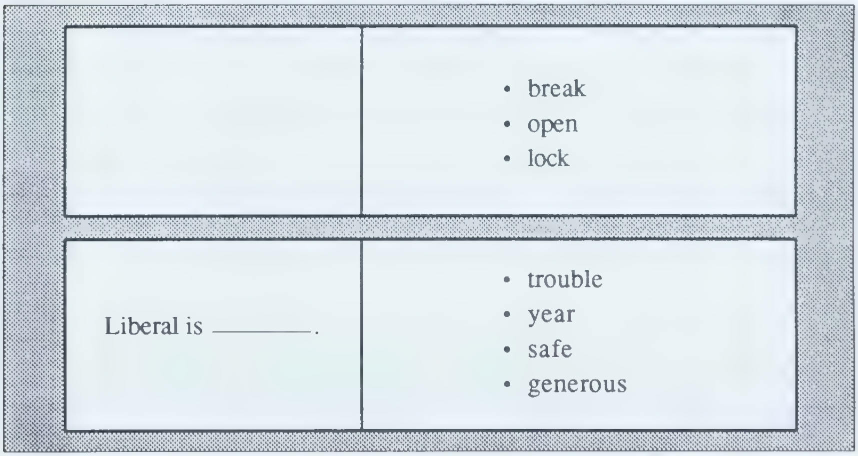
source of the material.*



- break
- open
- lock

Liberal is ______.

- trouble
- year
- safe
- generous

The Fitzhugh Plus Program
Action Verbs / Grammar and General Knowledge (above)

The typeface changes from section to section in this workbook giving the pages an inconsistent appearance. The horizontal presentation of response alternatives is less clear and therefore less appropriate than a vertical list of alternatives which facilitates the search for a correct response.

***Redesign** (below)*
In this layout, revised by the author of this thesis, the same typeface was used throughout the problems to give the page a more consistent appearance. Lists were placed along the same vertical line from problem to problem facilitating the search task and giving the page a sense of visual order and repose. Each possible response was marked with a bullet to emphasize the number of alternatives available.

Appendix 9

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source of the material.

Remediation of Reversals
In Kirschner's system letterforms are most often presented outside the context of a word. Some of the illustrations are ambiguous (hammer and nails) and some are unrecognizable (map of the USA).

No visual cue is provided in words where a missing letter is to be filled in. The relationship between the words and their corresponding images is weak. The illustrations are given more visual weight than the words and letters which are to be attended to. The condensed version of the typeface used makes the letterforms more difficult to discriminate and is, therefore, inappropriate.

Appendix **10**

Vowels

	˘	¯	°	"
a	**a**pple	**a**pron	**a**ll	**a**go
e	**e**ggs	**e**agle		
i	**i**nk	**i**ron		
o	**o**strich	**o**veralls		
u	**u**p	**u**nicorn		

Diphthongs

oa	b**oa**t
oi	c**oi**n
oo	b**oo**k
oo	m**oo**n
ou	h**ou**se

Consonants

b	**b**room
c	**c**at
d	**d**og
f	**f**ish
g	**g**rapes
h	**h**eart
j	**j**ar
k	**k**ey
l	**l**eaf
m	**m**ouse
n	**n**ail
p	**p**ig
q	**q**uilt
r	**r**ake
s	**s**eal
t	**t**ie
v	**v**est
w	**w**alrus
x	**x**-ray
y	**y**oyo
z	**z**ebra

Consonant blends

ch	**ch**eese
ng	stri**ng**
sh	**sh**eep
th	**th**ere
th	**th**read
wh	**wh**ale

Listed above are the 44 most common ***phonemes*** *or speech sounds in English with the words that have been chosen to represent these sounds on the letter tiles.*

Appendix 11a

Visual Communication Design
Master's Thesis Project

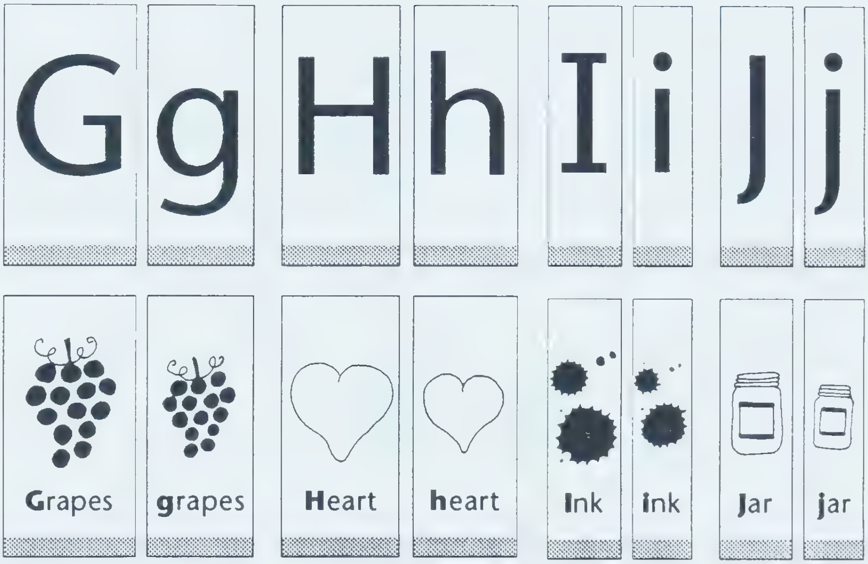
Short vowel and consonant letter tiles
upper and lowercase / front and back views

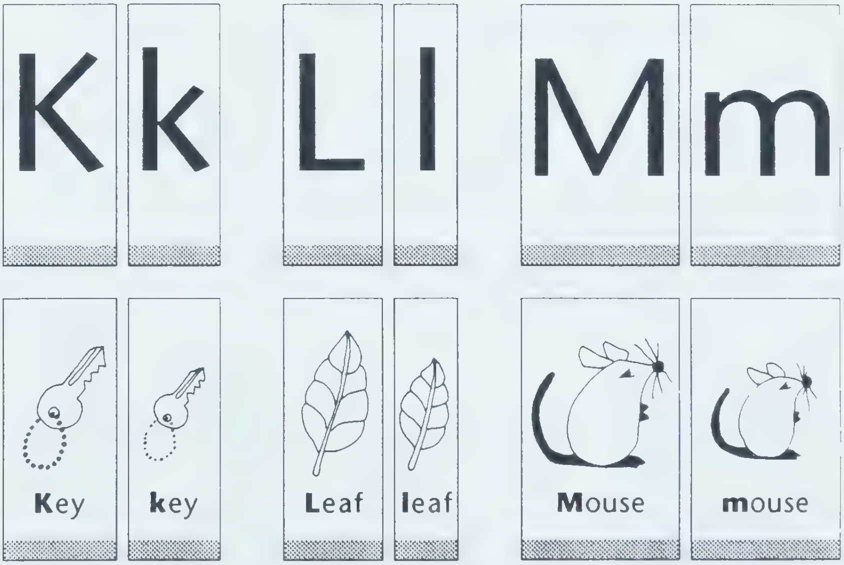
Letter tiles are shown ***actual size****. The tiles are approximately 3 mm thick. Full colour illustrations on tiles are shown here as line drawings.*

Mnemonic/identification cues, like the dot in the counter of the d, appear in red. Orientation cue "bars" appear in grey.

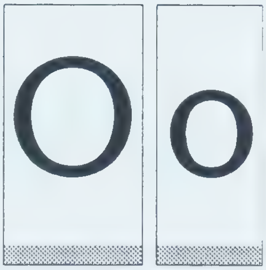
Appendix **11a**

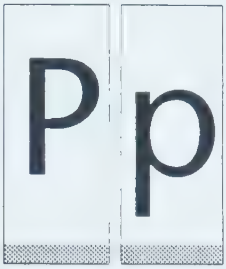
To aid letter recignition and identification, horizontal strokes have been added to the uppercase G and uppercase I.



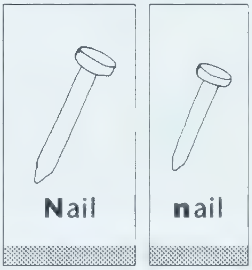


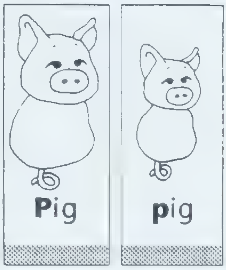
Appendix **11a**



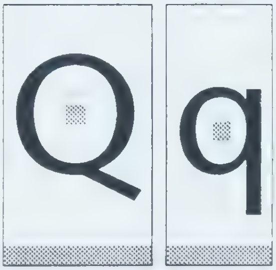


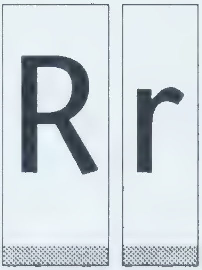
The bowls of the upper and lower-case ***Pp's*** *have been connected to facilitate identification.*

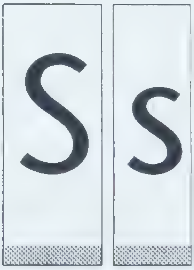


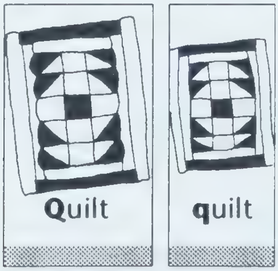


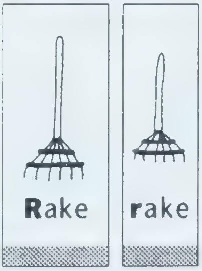
The mnemonic/identification cue for ***Qq*** *has been changed from a bowl to a red square because of information obtained during the evaluation.*



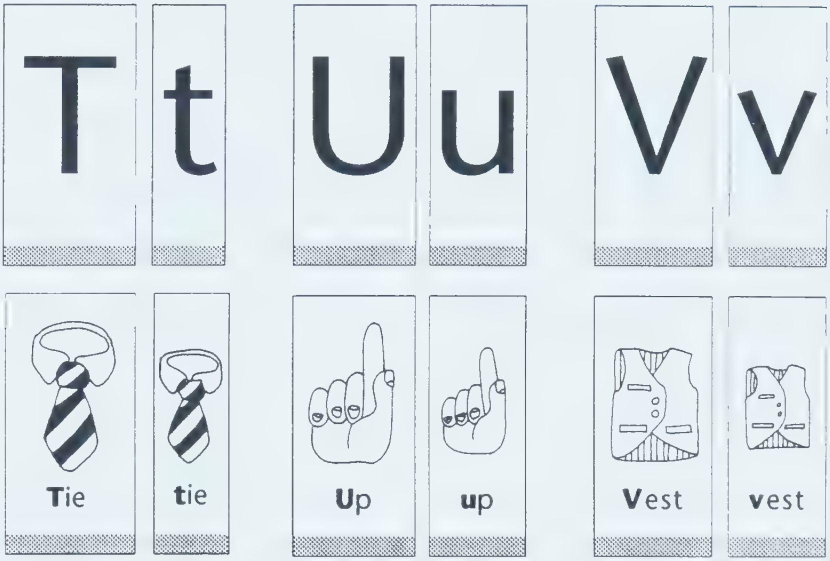




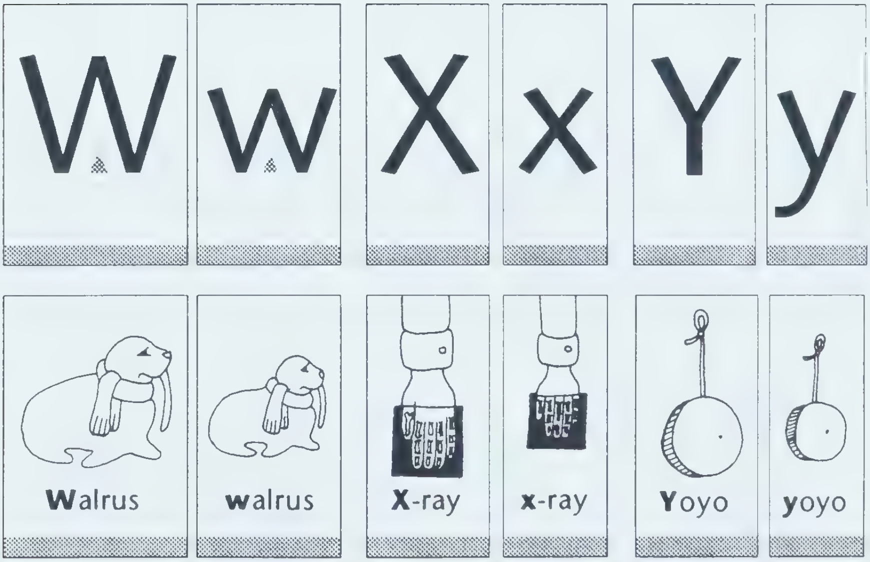




Appendix 11a

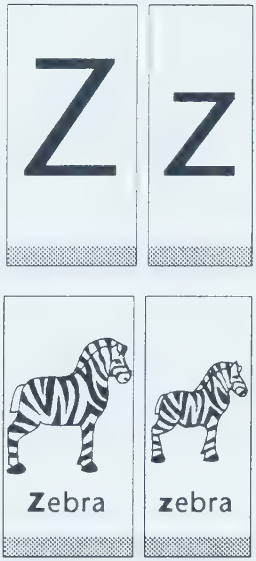


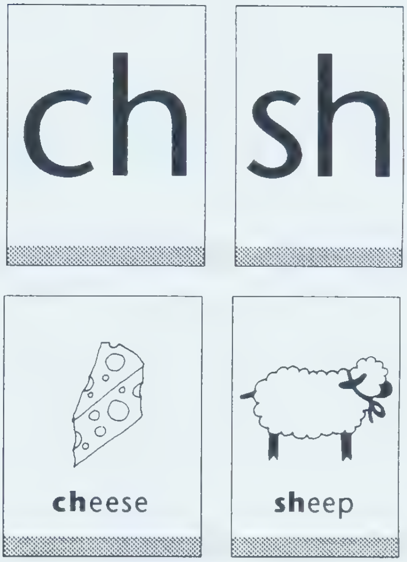
A red wedge has been added as a mnemonic/identification cue for Ww.



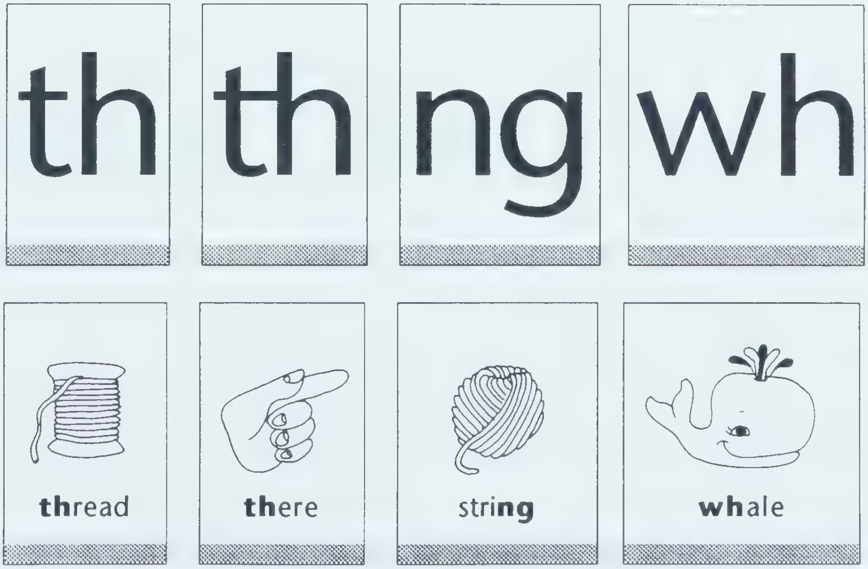
Appendix **11a/b**

Common consonant blend tiles
front and back views



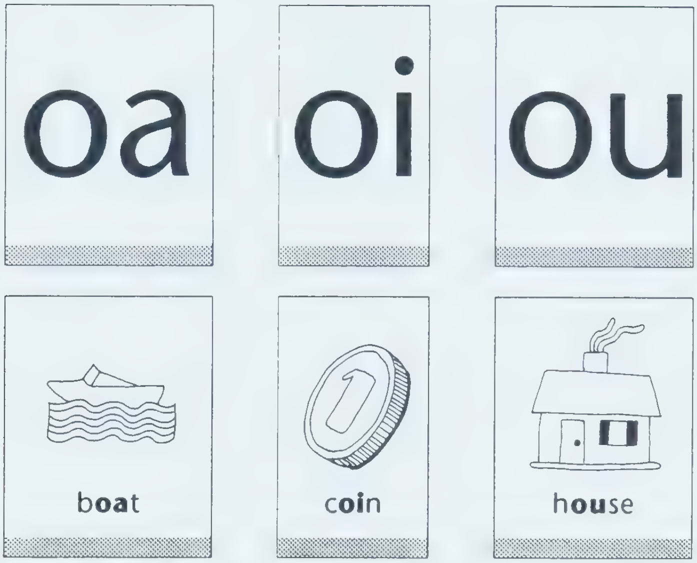


The sounds of the ***th*** *blends are differentiated by a horizontal stroke that has been added to the less prevalent of the two sounds.*

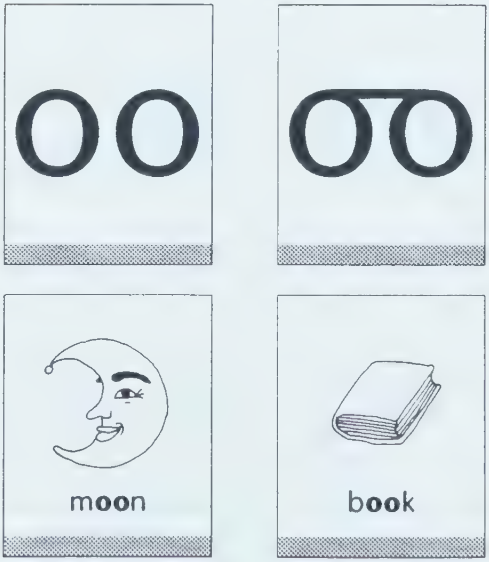


Appendix **11c**

Common diphthong tiles
front and back views



The sounds of the **oo** *diphthongs are differentiated by a horizontal stroke that has been added to the less prevalent, short oo sound.*



Appendix **11d**

Visual Communication Design
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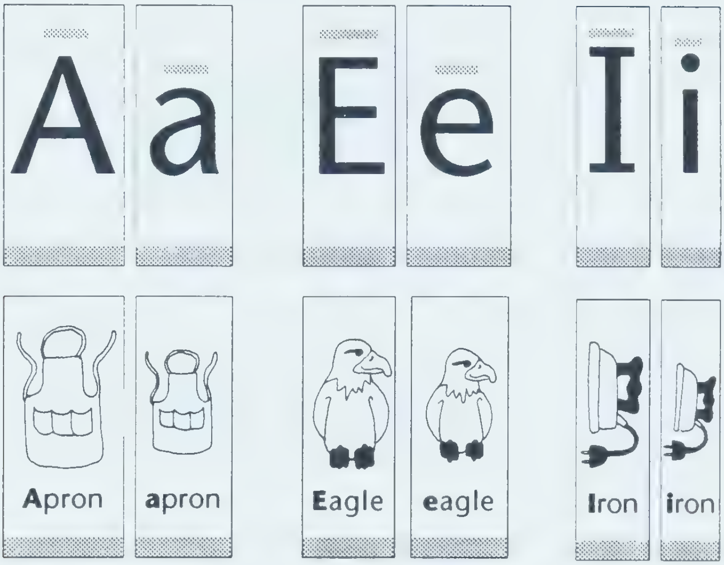
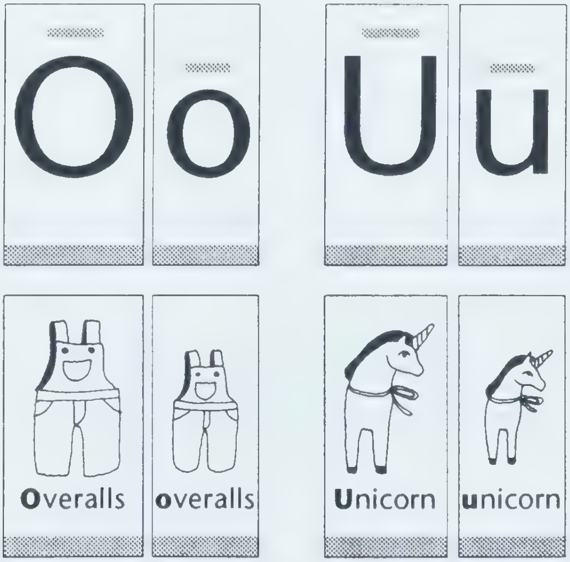
Long vowels letter tiles
upper and lowercase / front and back views



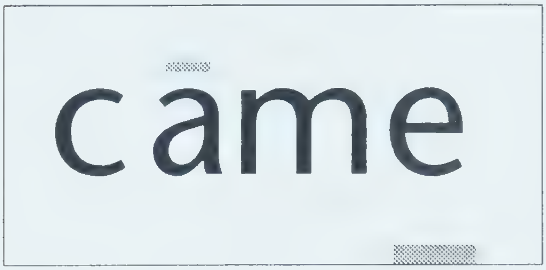
On the long vowel letter tiles, sounds are cued by grey rules that correspond to the markings for long vowel sounds in traditional pronunciation keys.



Appendix 11e

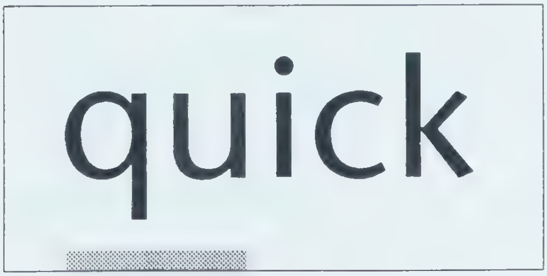
Visual Communication Design
Master's Thesis Project

Word card examples
with sound decoding and chunking cues



Single syllable words
The "bar" cues that, run along the bottom of the word cards, are here indicated in grey. They are in actuality red and indicate sounds that should be attended to during instruction.

Shown here are the:
- ***short double o** sound*
- ***silent e** with **long vowel***
- ***unaspirated th** sound*
- ***qu** sound with the **silent u***



Appendix **11e**

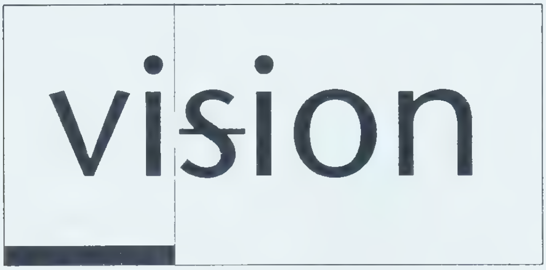
Single syllable words
Shown here is the card for the ***a*** *sound in the word ball with the typographic/mnemonic* ***ball*** *cue over it.*

Two syllable words
Syllables are divided by grey, vertical rules. Accented syllables are underlined by black rules that run along the bottom of the word cards.

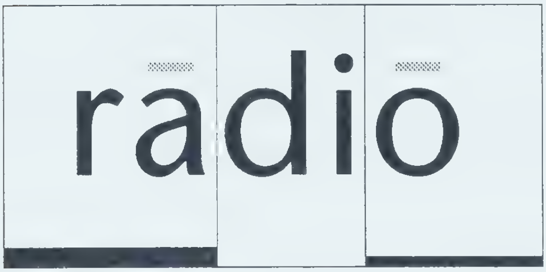
Here the first syllable of the word is accented. The typographic/ mnemonic cue for the ***soft c*** *sound is a grey circle. The* ***e*** *is silent.*

A ***soft g*** *sound is indicated by a grey dot in side the counter. The shape, location and colour of this cue relates to the cue for the* ***soft*** *c.*

Appendix **11e**



Multiple syllable words
The words on these cards are more complex than those used for beginnng reading instruction. They are meant as examples of how more complex word sound cues might be dealt with.



Visual Communication Design
Master's Thesis Project

Confusable sound pages
sample pages

confusable sounds

A **trip** in the rain makes you **drip**.

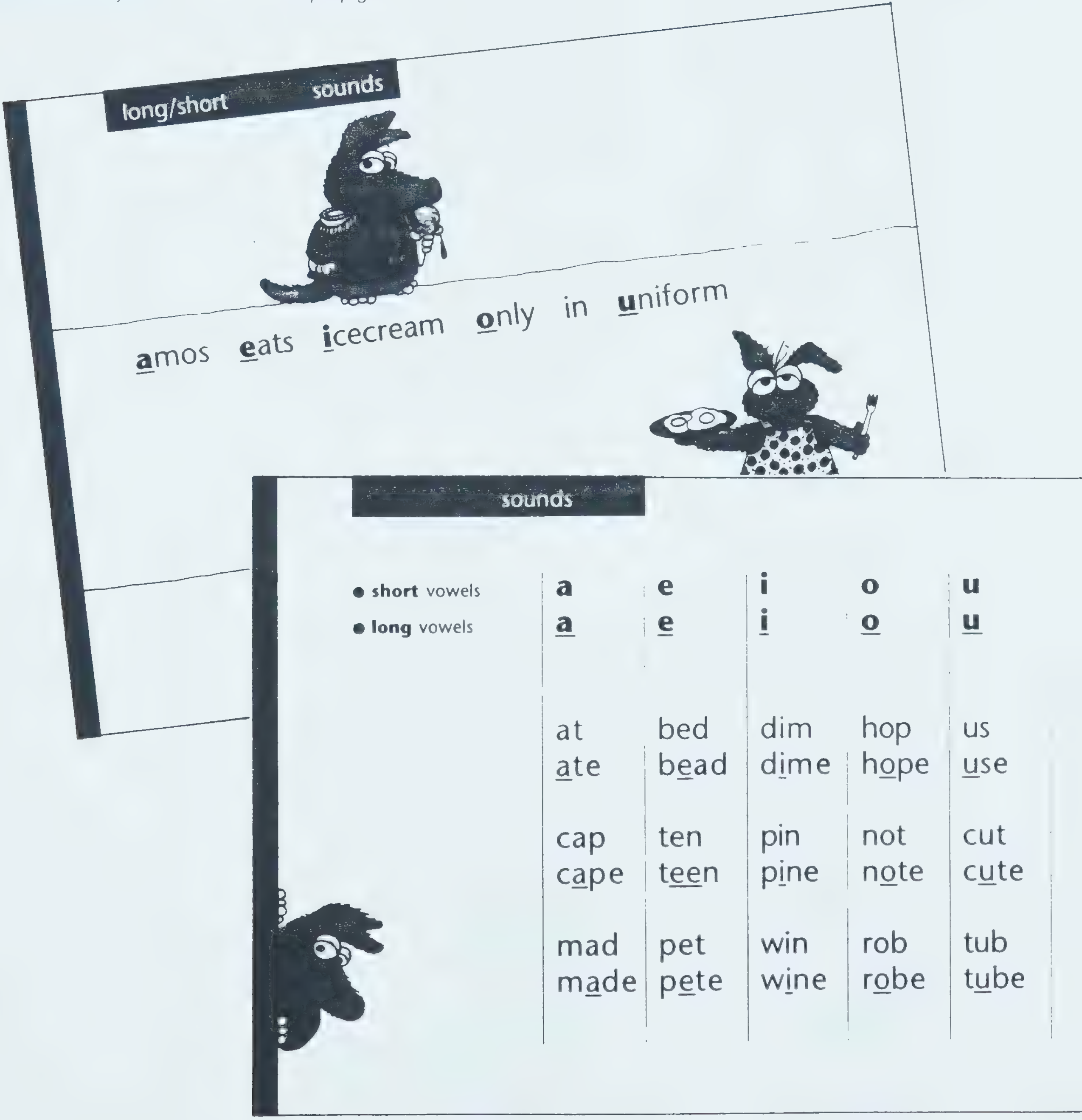
What a pain!

"You see I **choose**," he said,

"to wear my **shoes** in bed."

Appendix 11f

Long and short vowel sounds
sample pages



long/short sounds

amos **e**ats **i**cecream **o**nly in **u**niform

sounds

● **short** vowels	**a**	**e**	**i**	**o**	**u**
● **long** vowels	**a**	**e**	**i**	**o**	**u**
	at ate	bed bead	dim dime	hop hope	us use
	cap cape	ten teen	pin pine	not note	cut cute
	mad made	pet pete	win wine	rob robe	tub tube

References

Adelman, H.S. and Chaney, L.A. (1982) Impact of motivation on task performance of children with and without psychoeducational problems. *Journal of Learning Disabilities, 15,* 242-244.

Alley, G. and Deschler, D. (1979) *Teaching the Learning Disabled Adolescent: Strategies and Methods.* Denver: London.

Baddeley, A. (1984) Reading and Working Memory. *Visible Language,* XVIII, 4, 311-322.

Baddeley, A.D. and Lewis, V.J. (1981) Inner active processes in reading: The inner voice, the inner ear and the inner eye. In *Interactive Processes in Reading,* edited by A.M. Lesgold and C.J. Perfetti. Hillsdale, N.J.: Lawrence Erlbaum.

Bakker, D.J. (1979) Hemispheric differences and reading strategies: two dyslexias? *Bulletin of the Orton Society, 29,* 84-100.

– (1980) Hemisphere specific models and the therapies of dyslexia. Coloquium presented to the Division of Special Education and Rehabilitation, Syracuse University.

Bannatyne, A. (1966) The color phonics system. In *The Disabled Reader: Education of the Dyslexic Child,* edited by J. Money, Baltimore: Johns Hopkins Press.

– (1971) *Language, Reading and Learning Disabilities.* Springfield, Illinois: Charles C. Thomas.

Berger, N.S. (1978) Why can't John read? Perhaps he's not a good listener. *Journal of Learning Disabilities, 11,* 633-638.

Bernstein, M.C. (1967) Reading methods and materials based on linguistic principles for basic and remedial instruction. *Academic Therapy Quarterly, 2,* 149-154.

Birch, H.G. and Belmont, L. (1964) Auditory-visual integration in normal and retarded readers. *Journal of Orthopsychiatry, 34,* 852-861.

– (1965) Auditory-visual integration, intelligence, and reading ability in school children. *Perceptual and Motor Skills, 20,* 295-305.

Boder, E. (1973) Developmental dyslexia: A diagnostic approach based on three atypical reading-spelling patterns. *Developmental Medicine and Child Neurology, 15,* 663-687.

Bond, G. and Tinker, M. (1973) *Reading Difficulties: Their Diagnosis and Correction.* Englewood Cliffs, N.J.: Prentice Hall.

Borba, M. and Ungaro, D. (1980) *The Complete Letter Book: Multisensory Activities for Teaching Sounds and Letters.* Carthage, Illinois: Good Apple.

Bouma, H. (1970) Interaction effects in parafoveal letter recognition. *Nature, 266,* 177-178.

– (1971) Visual recognition of isolated lowercase letters. *Vision Research, 11,* 459-474.

– (1973) Visual interference in the parafoveal recognition of initial and final letters and words. *Vision Research, 13,* 767-782.

Bryant, N.D. (1980) Modifying instruction to minimize the effects of learning disabilities. *Forum,* 19-20.

Bruinincks, R.H. and Weatherman, R.F. (1970) *Handicapped children and special education program needs in northeast Minnesota.* Minneapolis: Department of Special Education, University of Minnesota.

Bruner, J.S., Olver, R.R., and Greenfield P.M. (1966) *Studies in Cognitive Growth.* New York: John Wiley and Sons.

Bryant, N.D. (1980) Modifying instruction to minimize the effects of learning disabilities. *Forum, 19-20.*

Bryden, M.P. and Allard, F. (1976) Visual hemifield differences depend on typeface. *Brain and Language, 3,* 191-200.

Carillo, Lawrence W. (1976) *Teaching Reading: A Handbook.* New York: St. Martins Press.

Coltheart, M. and Freeman, R. (1974) Case alternation impairs word identification. *Bulletin of the Psychonomic Society, 3,* 102-104.

Coop, R.H. and Sigel, I.E. (1971) Cognitive style: Implications for learning and instruction. *Psychology in the Schools, 8,* 152-161.

Cross, Nigel and Roy, Robin (1976) *Design Methods Manual.* Milton Keynes: The Open University.

Daves, W.F. (1975) *A Textbook of General Psychology.* New York: Thomas Y. Crowell.

Denckla, M.B. and Rudel, R.G. (1976a) Naming of object-drawings by dyslexic and other learning disabled children. *Brain and Language, 3,* 1-15.

Drew, C.J. and Altman, R. (1970) Effects of input organization and materi al difficulty on free recall. *Psychological Reports, 27,* 335-337.

Ebbinghaus, H. (1973) *Psychology: An Elementary Textbook.* New York: Arno.

Eisenson, J. (1972) *Aphasia in Children.* New York: Harper & Row.

Fernald, G.M. (1943) *Remedial Techniques in Basic School Subjects.* New York: McGraw Hill.

Fishbein, F.D. (1979) Braille phonics: A new technique for aiding the learning disabled. *Journal of Learning Disabilities, 12,* 60-64.

Fitzhugh, K. and Fitzhugh, L. (1975) *The Fitzhugh Plus Program: Placement Guide and Teacher's Manual.* Galien, Michigan: Allied Education Council.

Flavell, J.H. and Wellman, H. (1976) Metamemory. In *Memory in Cognitive Development,* edited by R.V. Kail and J.W. Hagen. Hillsdale, N.J.: Lawrence Erlbaum.

Frostig, M. (1980) Meeting individual needs of all children in the classroom setting. *Journal of Learning Disabilities, 13,* 158-161.

Frostig, M. and Horne, D. (1964) *The Frostig program for the development of visual perception.* Palo Alto: Consulting Psychology Press.

Fry, E.B. (1963) *Teaching Machines and Programmed Instruction.* New York: McGraw Hill.

Fujimura, O. (1975) Syllable as a unit of speech perception, *IEEE Transactions on Acoustics: Speech and Signal Processing, ASSP-23,* 82-86.

Gattegno, C. (1962) *Words in Color.* Chicago Learning Materials.

Gattegno, C. and Hinman, D. (1966) Words in Color. In *The Disabled Reader,* edited by J. Money and G. Schiffman. Baltimore: Johns Hopkins Press.

Geschwind, N. (1970) The organization of language and the brain. *Science, 170,* 940-944.

Gibson, E.J. (1965) Learning to Read. *Science, 145,* 1066-1072.

– (1969) *Principles of Perceptual Learning and Development.* New York: Appleton-Century-Crofts.

– (1971) Perceptual Learning and the theory of word perception. *Cognitive Psychology, 2,* 351-368.

Gibson, E.J. and Levin, H. (1975) Introduction. *The Psychology of Reading.* Cambridge: MIT Press.

Gillingham, A. and Stillman, B. (1970) *Remedial Training for Children with Specific Disability in Reading, Spelling and Penmanship.* Cambridge: Educator's Publishing Service.

Goodman, Y. and Burke, C.L. (1972) *Reading Miscue Inventory Manual: Procedure for Diagnosis and Evaluation.* New York: Macmillan.

Haber, R.N. (1970) How we remember what we see. *Scientific American, 222 (5),* 104-112.

Hagen, J.W., Jongeward, R.H. and Kail, R.V. (1975) Cognitive perspectives on the development of memory. In *Advances in Child Development an Behavior,* Volume 10, edited by H.W. Reese. New York: Academic Press.

Hammill, D.D., Leigh, J.E., McNutt, G. and Larsen, S.C. (1981) A new definition of learning disabilities. *Learning Disability Quarterly,* 4(4), 336-342.

Hanna, P.R., Hodges, R.E. and Hanna, J.S. (1971) *Spelling, Structure and Strategies.* Boston: Houghton Mifflin.

Harris, L., Schaller, M., and Mitler, M. (1970) The effects of stimulus type on performance in a color-form sorting task with preschool, kindergarten, first grade, and third grade children, *Child Development, 41,* 177-191.

Hartley J. (1978) *Designing Instructional Text.* New York: Nichols.

– (1980) *The psychology of written communication.* New York: Kogan Page.

Heckelman, R.C. (1969) A neurological impress method of remedial reading. *Academic Therapy, 4,* 277-282.

Heilman, A.W. (1968) *Phonics in Proper Perspective.* Columbus, Ohio: Charles E. Merrill.

Hock, H. and Hilton, T. (1979) Spatial coding and oblique discrimination by children. *Journal of Experimental Child Psychology, 27,* 96-104.

Hunt, D.E., Joyce, B.R., Greenwood, J., Noy, J.E., Reid, R. and Weil, M. (1974) Student conceptual level and models of teaching: Theoretical and empirical coordination of two models. *Interchange, 5,* 19-30.

Johnson, D. and Myklebust, H. (1967) *Learning Disabilities: Educational Principles and Practices.* New York: Grune/Stratton.

Kahn, D. and Birch, H.G. (1968) Development of auditory-visual integration and reading achievement. *Perceptual and Motor Skills, 27,* 459-468.

Kephart, N.C. (1971) Forward. In *Hard, Seguin and Kephart: Sensory Education, a Learning Interpretation,* edited by T.S. Ball. Columbus, Ohio: Charles E. Merrill.

Kinsbourne, M. and Caplan, P. (1979) *Children's Learning and Attention Problems.* Boston: Little, Brown.

Kirk, S.A. and Kirk, W.D. (1971) Psycholinguistic Learning Disabilities: Diagnosis and Remediation. Chicago: University of Illinois Press.

Kirschner, A.J. (1977) Remediation of Reversals. Novato, California: Academic Therapy Communications.

Koenigsberg, R.S. (1973) An evaluation of visual versus sensorimotor methods for improving orientation discrimination for letter reversals by preschool children. *Child Development, 44,* 764-769.

Krailing, T. (1988) *How to Write for Children.* London: Alison and Busby.

Krieger, V.K. (1981) A hierarchy of "confusable" high frequency words in isolation and in context. *Learning Disabilities Quarterly,* 4(2), 131-138.

Ladan, C.J. (1977) Three variables influencing the picture preferences of south and north american boys and girls. *Reading Improvement, (2),* 14, 120-128.

Lam, C.D. (1969) Pupil preference for four art styles used in primary reading textbooks. *The Reading Teacher, 23,* 137-143.

Langer, Helmut (1989) Visual design: identity and perspective. *Icograda Message Board.* Statement on the occasion of accepting the presidency. London: Icograda.

Levie, W.H. (1973) Pictorial Research: an overview. *Viewpoints, 49,* (2), 37-45.

Liberman, I.Y., Shankweiler, D., Fisher, F.W. and Carter, B. (1974) Reading and the awareness of linguistic segments. *Journal of Experimental Child Psychology, 18,* 201-212.

Liberman, I.Y., Shankwieler, D., Shankweiler, A.M., Fowler, C. and Fischer, F.W. (1977) Phonetic Segmentation and recoding in the beginning reader. In *Towards a Psychology of Beginning Reading,* edited by A.S. Reber and D. Scarborough. Hillsdale, N.J.: Lawrence Erlbaum.

Luria, A. (1961) *The Role of Speech in the Regulation of Normal and Abnormal Behavior.* New York: Liveright.

Massaro, D.W. (1979) Reading and Listening (Tutorial Paper). In *Processing Visible Language, Volume 1,* edited by P.A. Kolers, W.E. Wrolstad, and H. Bouma. New York: Plenum Press.

Massaro, D.W. and Klitzke, D. (1977) Letters are functional in word identification. *Memory and Cognition, 15,* 292-298.

Meichenbaum, D. (1977) *Cognitive Behavior Modification: An Integrative Approach.* New York: Plenum.

Miller, G.A. (1956) The magical number seven, plus or minus two: Some limits on our capacity for processing information. *The Psychological Review, 63,* 81-97.

Montessori, M. (1961) *The Montessori Method.* Cambridge: MIT Press.

Perfetti, C.A. and Lesgold, A.M. (1977) Coding and comprehension in skilled reading and implications for reading instruction. In *Theory and Practice in Early Reading,* edited by L.B. Resnick and P. Weaver. Hillsdale, N.J.: Lawrence Erlbaum.

Piaget, J. (1954) *The Construction of Reality in the Child.* New York: Basic Books.

– (1962) *Language and Thought of the Child.* New York: World Publishing.

– (1963) *The Origins of Intelligence in Children.* New York: W.W. Norton.

Piaget, J. and Inhelder, B. (1956) *The Child's Conception of Space.* London: Routledge & Kegan Paul.

Pitman, J. (1964) *i/t/a.* Toronto: Society of Typographic Designers of Canada Format 1, 6-9.

Porter, A.W. (1974) *Shape and Form.* Worchester, Massachusetts: Davis.

Poteet, J.A. (1980) Informal assessment of written expression. *Learning Disability Quarterly, 3*(4), 88-89.

Reich, S.S. and Cherry, C. (1979) A Direct Access from Graphics to Meaning. In *Processing Visible Language, Volume 1,* edited by P.A. Kolers, W.E. Wrolstad, and H. Bouma. New York: Plenum.

Rosen, C.L. (1966) An experimental study of visual perceptual training and reading achievement in first grade. *Perceptual and Motor Skills, 22,* 979-986.

Rosner, J. (1975) *Helping Children Overcome Learning Difficulties.* New York: Walker.

Roth Smith, Corrinne (1983) *Learning Disabilities: The Interaction of Learner, Task and Setting.* Toronto: Little Brown & Company.

Rudnick, M., Sterritt, G.M. and Flax, M. (1967) Auditory and visual rhythm perception and reading ability. *Child Development, 38,* 581-587.

Sabatino, D.H. and Hayden, D.L. (1970) Prescriptive teaching in a summer learning disabilities program. *Journal of Learning Disabilities, 3,* 220-227.

Shankweiler, D. and Liberman, I.Y. (1976) Exploring the relations between reading and speech. In *The Neuropsychology of Learning Disorders: Theoretical Approaches,* edited by R.M. Knights and D.J. Bakker. Baltimore: University Park Press.

– (1972) Misreading: a search for causes. In *Language by Ear and by Eye: the Relationship Between Speech and Reading,* edited by J.F. Kavanagh and I.G. Mattingly. Cambridge: MIT Press.

Sheingold, K. and Shapiro, J. (1976) Children's verbal rehearsal in a free-recall task. *Developmental Psychology, 12,* 169-170.

Siegel, L.S. and Linder, B.A. (1984) Short-term memory processes in children with reading and arithmetic learning disabilities. *Developmental Psychology, 20,* 20-207.

Spencer, H. (1968) *The visible word.* New York: Hastings House.

Sperry, V.B. (1974) *A Language Approach to Learning Disabilities,* Palo Alto: Consulting Psychologists Press.

Spring, C. and Capps, C. (1974) Encoding speed, rehearsal, and probed recall in dyslexic boys. *Journal of Educational Psychology, 66,* 780-786.

Standing, L. (1973) "Learning 10,000 pictures," *Quarterly Journal of Educational Psychology,* 25, 207-222.

Stewig, J.W. (1975) Assessing visual elements preferred in pictures by young children. *Reading Improvement,* 12, 94-97.

Swartz, S. (1984) *Measuring Reading Competence.* New York: Plenum Press.

Tabor, J.I., Glaser, K. and Shaefer, H.R. (1965) *Learning and Programmed Instruction.* Reading, Massachusetts: Addison Wesley.

Taylor, Insup and Taylor, M.M. (1983) *The Psychology of Reading.* New York: Academic Press.

Tinker, M.A. (1963) *Legibility of Print.* Ames: Iowa State University.

Torgesen, J.K. (1980) Conceptual and educational implications of the use of efficient task strategies by learning disabled children. *Journal of Learning Disabilities, 13,* 364-371.

Torgesen, J.K. and Houck, D.G. (1980) Processing deficiencies of learning-disabled children who perform poorly on the digit span test. *Journal of Educational Psychology, 72,* 141-160.

Torgesen, J.K., Murphy, H.A. and Ivey, C. (1979) The influence of an orienting task on the memory performance of children with reading problems. *Journal of Learning Disabilities,* 12, 396-401.

Townsend, J.T. (1971) Alphabetic confusion: A test of models for individuals, *Perception and Psychophysics, 9,* 40-50.

U.S. Office of Education (1968) *First Annual Report, National Advisory Committee on Handicapped Children.* Washington, D.C.: U.S. Department of Health, Education and Welfare.

Vellutino, F.R. (1987) Dyslexia. *Scientific American.* 256(3), 34-41.

Vellutino, F.R., Smith, H., Steger, J.A. and Kaman, M. (1975) Reading disability: age differences and the perceptual deficit hypothesis. *Child Development, 46,* 487-493.

Vernon, M., Coley, J. and DeBois, J. (1980) Using sign language to remediate severe reading problems. *Journal of Learning Disabilities, 13,* 215-218.

Wallis Burke, P. (1975) The myth of the 26 letter roman alphabet. *Edugraphic/Icographic,* 9, 4-15.

Wiig, E.H. and Semel, E.M. (1980) *Language Assessment and Intervention for the Learning Disabled.* Columbus, Ohio: Charles E. Merrill.

Woodcock, R.W. and Clarke, C.R. (1969) *Peabody Rebus Reading Program.* Circle Pines, Minnesota: American Guidance Service.

Zigmond, N., Vallecorsa, A. and Leinhardt, G. (1982) Reading instruction for students with learning disabilities. In *Language Disorders and Learning Disabilities,* edited by K.B. Butler and G.P. Wallach. Rockville, MD: Aspen.

Bibliography

Aaron, P.G., Bommarito, T. and Baker, C. (1984) The three phases of developmental dyslexia. In *Dyslexia: A Global Issue, NATO ASI Series D, 18,* edited by R.N. Malatesha, and H.A. Whitaker. The Hague: Martinus Nijhoff.

Adelman, H.S. and Chaney, L.A. (1982) Impact of motivation on task performance of children with and without psychoeducational problems. *Journal of Learning Disabilities, 15,* 242-244.

Alley, G. and Deschler, D. (1979) *Teaching the Learning Disabled Adolescent: Strategies and Methods.* Denver: London.

Allport, A. (1979) Word Recognition in Reading (Tutorial Paper). In *Processing Visible Language, Volume 1,* edited by P.A. Kolers, W.E. Wrolstad, and H. Bouma. New York: Plenum Press.

Arroyo, F.V. (1984) The importance of grapheme-to-phoneme conversion rules in beginning readers. In *Dyslexia: A Global Issue, NATO ASI Series D, 18,* edited by R.N. Malatesha, and H.A. Whitaker. The Hague: Martinus Nijhoff.

Baddeley, A.D. (1979) Working Memory and Reading. In *Processing Visible Language, Volume 1,* edited by P.A. Kolers, W.E. Wrolstad, and H. Bouma. New York: Plenum Press.

– (1984) Reading and Working Memory. *Visible Language,* XVIII, *4,* 311-322.

Baddeley, A.D. and Lewis, V.J. (1981) Inner active processes in reading: The inner voice, the inner ear and the inner eye. In *Interactive Processes in Reading,* edited by A.M. Lesgold and C.J. Perfetti. Hillsdale, N.J.: Lawrence Erlbaum.

Bailey, C.A. and Pirozzolo, F.J. (1984) Visual half-field studies of developmental reading disability. In *Dyslexia: A Global Issue, NATO ASI Series D, 18,* edited by R.N. Malatesha, & H.A.Whitaker. The Hague: Martinus Nijhoff.

Baker, C.D., and Freebody, P. (1989) *Children's First School Books: Introductions to the Culture of Literacy.* Cambridge: Basil Blackwell.

Bakker, D.J. (1979) Hemispheric dif-ferences and reading strategies: two dyslexias? *Bulletin of the Orton Society, 29,* 84-100.

– (1980) Hemisphere specific models and the therapies of dyslexia. Coloquium presented to the Division of Special Education and Rehabilitation, Syracuse University.

Bannatyne, A. (1966) The color phonics system. In *The Disabled Reader: Education of the Dyslexic Child,* edited by J. Money, Baltimore: Johns Hopkins Press.

– (1971) *Language, Reading and Learning Disabilities.* Springfield, Illinois: Charles C. Thomas.

Berger, N.S. (1978) Why can't John read? Perhaps he's not a good listener. *Journal of Learning Disabilities, 11,* 633-638.

Bernstein, M.C. (1967) Reading methods and materials based on linguistic principles for basic and remedial instruction. *Academic Therapy Quarterly, 2,* 149-154.

Birch, H.G. and Belmont, L. (1964) Auditory-visual integration in normal and retarded readers. *Journal of Orthopsychiatry, 34,* 852-861.

– (1965) Auditory-visual integration, intelligence, and reading ability in school children. *Perceptual and Motor Skills, 20,* 295-305.

Boder, E. (1973) Developmental dyslexia: A diagnostic approach based on three atypical reading-spelling patterns. *Developmental Medicine and Child Neurology, 15,* 663-687.

Boder, E. and Jarrico, S. (1984) A diagnostic screening test for sub-types of dyslexia: The Boder Test of reading-spelling patterns. In *Dyslexia: A Global*

Issue, NATO ASI Series D, 18, edited by R.N. Malatesha, and H.A. Whitaker. The Hague: Martinus Nijhoff.

Bond, G. and Tinker, M. (1973) *Reading Difficulties: Their Diagnosis and Correction.* Englewood Cliffs, New Jersey: Prentice Hall.

Borba, M. and Ungaro, D. (1980) *The Complete Letter Book: Multisensory Activities for Teaching Sounds and Letters.* Carthage, Illinois: Good Apple.

Bos, K. van den (1982) Learning disabled children's performance in spatial tasks. In *Neuropsychology and Cognition, Volume II,* edited by R.N. Malatesha and L.C. Hartlage. The Hague: Martinus Nijhoff.

Bouma, H. (1970) Interaction effects in parafoveal letter recognition. *Nature, 266,* 177-178.

– (1971) Visual recognition of isolated lowercase letters. *Vision Research, 11,* 459-474.

– (1973) Visual interference in the parafoveal recognition of initial and final letters and words. *Vision Research, 13,* 767-782.

Bouma, H. and Legein, C.P. (1984) In search of the core of dyslexia: Analysis of the reading process of dyslexic children. In *Dyslexia: A Global Issue, NATO ASI Series D, 18,* edited by R.N. Malatesha, and H.A. Whitaker. The Hague: Martinus Nijhoff.

Bouwhuis, D.G. (1979) Word Knowledge and Letter Recognition as Determinants of Word Recognition. In *Processing Visible Language, Volume 1,* edited by P.A. Kolers, W.E. Wrolstad, and H. Bouma. New York: Plenum Press.

Bruinincks, R.H. and Weatherman, R.F. (1970) *Handicapped children and special education program needs in northeast Minnesota.* Minneapolis: Department of Special Education, University of Minnesota.

Bruner, J.S., Olver, R.R., and Greenfield P.M. (1966) *Studies in Cognitive Growth.* New York: John Wiley and Sons.

Bryant, N.D. (1980) Modifying instruction to minimize the effects of learning disabilities. *Forum,* 19-20.

Bryant, P.E. and Bradley, L. (1980) Why children sometimes write words which they do not read. In *Cognitive Processes in Spelling,* edited by U. Frith. London: Academic Press.

Bryden, M.P. and Allard, F. (1976) Visual hemifield differences depend on typeface. *Brain and Language, 3,* 191-200.

Burd, G. (1984) Dyslexia–Diagnosis and treatment from the perspective of a reading specialist. In *Dyslexia: A Global Issue, NATO ASI Series D, 18,* edited by R.N. Malatesha, and H.A. Whitaker. The Hague: Martinus Nijhoff.

Carillo, Lawrence W. (1976) *Teaching Reading: A Handbook.* New York: St. Martins Press.

Coltheart, M. (1984) Acquired dyslexias and normal reading. In *Dyslexia: A Global Issue, NATO ASI Series D, 18,* edited by R.N. Malatesha, and H.A. Whitaker. The Hague: Martinus Nijhoff.

Coltheart, M. and Freeman, R. (1974) Case alternation impairs word identification, *Bulletin of the Psychonomic Society, 3,* 102-104.

Coop, R.H. and Sigel, I.E. (1971) Cognitive style: Implications for learning and instruction. *Psychology in the Schools, 8,* 152-161.

Cross, Nigel and Roy, Robin (1976) *Design Methods Manual.* Milton Keynes: The Open University.

Daves, W.F. (1975) *A Textbook of General Psychology.* New York: Thomas Y. Crowell.

Denckla, M.B. and Rudel, R.G. (1976a) Naming of object-drawings by dyslexic and other learning disabled children. *Brain and Language, 3,* 1-15.

Drew, C.J. and Altman, R. (1970) Effects of input organization and material difficulty on free recall. *Psychological Reports, 27,* 335-337.

Dunn, K.P. and Pirozzolo, F.J. (1984) Eye movements in developmental dyslexia. In *Dyslexia: A Global Issue, NATO ASI Series D, 18,* edited by R.N. Malatesha, and H.A. Whitaker. The Hague: Martinus Nijhoff.

Easterby, R. and Zwaga, H. (1984) *Information Design.* Chichester: John Wiley and Sons.

Ebbinghaus, H. (1973) *Psychology: An Elementary Textbook.* New York: Arno Publishing.

Eisenson, J. (1972) *Aphasia in Children.* New York: Harper & Row.

Eling, P. (1984) Temporal order perception and lateralization in dyslexic children. In *Dyslexia: A Global Issue, NATO ASI Series D, 18,* edited by R.N. Malatesha, and H.A. Whitaker. The Hague: Martinus Nijhoff.

Fernald, G.M. (1943) *Remedial Techniques in Basic School Subjects.* New York: McGraw Hill.

Fishbein, F.D. (1979) Braille phonics: A new technique for aiding the learning disabled. *Journal of Learning Disabilities, 12,* 60-64.

Fitzhugh, K. and Fitzhugh, L. (1975) *The Fitzhugh Plus Program: Placement Guide and Teacher's Manual.* Galien, Michigan: Allied Education Council.

Flavell, J.H. and Wellman, H. (1976) Metamemory. In *Memory in Cognitive Development,* edited by R.V. Kail and J.W. Hagen. Hillsdale, New Jersey: Lawrence Erlbaum.

Fowler, R. (1974) *Understanding Language: An Introduction to Linguistics.* London: Routledge & Kegan Paul.

Frascara, J.D. (1979) Pattern Design and Literacy for the Retarded. *Icographic, 14/15.* London: Icograda, 14-15.

Frith, U. (1979) Reading by Eye and Writing by Ear. In *Processing Visible Language, Volume 1,* edited by P.A. Kolers, W.E. Wrolstad, and H. Bouma. New York: Plenum Press.

Frostig, M. (1980) Meeting individual needs of all children in the classroom setting. *Journal of Learning Disabilities, 13,* 158-161.

Frostig, M. and Horne, D. (1964) *The Frostig program for the development of visual perception.* Palo Alto: Consulting Psychology Press.

Fry, E.B. (1963) *Teaching Machines and Programmed Instruction.* New York: McGraw Hill.

Fujimura, O. (1975) Syllable as a unit of speech perception, *IEEE Transactions on Acoustics: Speech and Signal Processing, ASSP-23,* 82-86.

Gattegno, C. (1962) *Words in Color.* Chicago Learning Materials.

Gattegno, C. and Hinman, D. (1966) Words in Color. In *The Disabled Reader,* edited by J. Money and G. Schiffman. Baltimore: Johns Hopkins Press.

Geschwind, N. (1970) The organization of language and the brain. *Science, 170,* 940-944.

Gibson, E.J. (1965) Learning to Read. *Science, 145,* 1066-1072.

– (1969) *Principles of Perceptual Learning and Development.* New York: Appleton-Century-Crofts.

– (1971) Perceptual Learning and the theory of word perception. *Cognitive Psychology, 2,* 351-368.

Gibson, E.J. and Levin, H. (1975) Introduction. *The Psychology of Reading*. Cambridge: MIT Press.

Gillingham, A. and Stillman, B. (1970) *Remedial Training for Children with Specific Disability in Reading, Spelling and Penmanship*. Cambridge: Educator's Publishing Service.

Goldsmith, J.S. and Nicholic, M.J. (1984) On the use of word and context based information sources evaluated by oral reading error analysis. In *Dyslexia: A Global Issue, NATO ASI Series D, 18,* edited by R.N. Malatesha, and H.A. Whitaker. The Hague: Martinus Nijhoff.

Goodman, Y. and Burke, C.L. (1972) *Reading Miscue Inventory Manual: Procedure for Diagnosis and Evaluation*. New York: Macmillan.

Haber, R.N. (1970) How we remember what we see. *Scientific American, 222 (5),* 104-112.

Hagen, J.W., Jongeward, R.H. and Kail, R.V. (1975) Cognitive perspectives on the development of memory. In *Advances in Child Development an Behavior,* Volume 10, edited by H.W. Reese. New York: Academic Press.

Hallahan, D.P. and Kauffman, J.M. (1976) *Introduction to Learning Disabilities: A Psycho-Behavioral Approach*. Englewood Cliffs: Prentice Hall.

Hammill, D.D., Leigh, J.E., McNutt, G. and Larsen, S.C. (1981) A new definition of learning disabilities. *Learning Disability Quarterly*, 4(4), 336-342.

Hanna, P.R., Hodges, R.E. and Hanna, J.S. (1971) *Spelling, Structure and Strategies*. Boston: Houghton Mifflin.

Harris, L., Schaller, M., and Mitler, M. (1970) The effects of stimulus type on performance in a color-form sorting task with preschool, kindergarten, first grade, and third grade children, *Child Development, 41,* 177-191.

Hartley J. (1978) *Designing Instructional Text*. New York: Nichols.

– (1980) *The psychology of written communi cation*. New York: Kogan Page.

Heckelman, R.C. (1969) A neurological impress method of remedial reading. *Academic Therapy, 4,* 277-282.

Heilman, A.W. (1968) *Phonics in Proper Perspective*. Columbus, Ohio: Charles E. Merrill.

Henderson, L. (1982) *Orthography and Word Recognition in Reading*. London: Academic Press.

Hock, H. and Hilton, T. (1979) Spatial coding and oblique discrimination by children. *Journal of Experimental Child Psychology, 27,* 96-104.

Huey, E.G. (1908) *The Psychology and Pedagogy of Reading*. Cambridge: MIT Press.

Hulme, C. and Bradley, L. (1984) An experimental study of multi-sensory teaching with normal and retarded readers. In *Dyslexia: A Global Issue, NATO ASI Series D, 18,* edited by R.N. Malatesha, and H.A. Whitaker. The Hague: Martinus Nijhoff.

Hunt, D.E., Joyce, B.R., Greenwood, J., Noy, J.E., Reid, R. and Weil, M. (1974) Student conceptual level and models of teaching: Theoretical and empirical coordination of two models. *Interchange, 5,* 19-30.

Johnson, D. and Myklebust, H. (1967) *Learning Disabilities: Educational Principles and Practices*. New York: Grune & Stratton.

Kahn, D. and Birch, H.G. (1968) Development of auditory-visual integration and reading achievement. *Perceptual and Motor Skills, 27,* 459-468.

Kephart, N.C. (1971) Forward. In *Hard, Seguin and Kephart: Sensory Education,a Learning Interpretation*, edited by T.S. Ball. Columbus, Ohio: Charles E. Merrill.

Kinsbourne, M. and Caplan, P. (1979) *Children's Learning and Attention Problems*. Boston: Little, Brown.

Kirk, S.A. and Kirk, W.D. (1971) Psycholinguistic Learning Disabilities: Diagnosis and Remediation. Chicago: University of Illinois Press.

Kirschner, A.J. (1977) Remediation of Reversals. Novato, California: Academic Therapy Communications.

Koenigsberg, R.S. (1973) An evaluation of visual versus sensorimotor methods for improving orientation discrimination for letter reversals by preschool children. *Child Development, 44*, 764-769.

Krailing, T. (1988) *How to Write for Children*. London: Alison and Busby.

Kolers, P.A. (1970) Three Stages of Reading. In *Basic Studies in Reading*, edited by H. Levin and J.P. Williams. New York: Basic Books

Kremin, H. (1984) Comments on pathological reading behavior due to lesions on the left hemisphere. In *Dyslexia: A Global Issue, NATO ASI Series D, 18*, edited by R.N. Malatesha, and H.A. Whitaker. The Hague: Martinus Nijhoff.

– (1984) Word recognition and word production: Data from pathology. In *Dyslexia: A Global Issue, NATO ASI Series D, 18*, edited by R.N. Malatesha, and H.A. Whitaker. The Hague: Martinus Nijhoff.

Krieger, V.K. (1981) A hierarchy of "confusable" high frequency words in isolation and in context. *Learning Disabilities Quarterly*, 4(2), 131-138.

Ladan, C.J. (1977) Three variables influencing the picture preferences of south and north american boys and girls. *Reading Improvement, (2), 14*, 120-128.

Lam, C.D. (1969) Pupil preference for four art styles used in primary reading textbooks. *The Reading Teacher, 23*, 137-143.

Langer, Helmut (1989) Visual design: identity and perspective. *Icograda Message Board*. Statement on the occasion of accepting the presidency. London: Icograda.

Laurinen, P. and Nyman, G. (1984) Information Value of print size on reading performance. In *Dyslexia: A Global Issue, NATO ASI Series D, 18*, edited by R.N. Malatesha, and H.A. Whitaker. The Hague: Martinus Nijhoff.

Leisman, G. and Zenhausern, R. (1982) Integratory systems deficits in developmental dyslexia. In *Neuropsychology and Cognition, Volume II*, edited by R.N. Malatesha and L.C. Hartlage. The Hague: Martinus Nijhoff.

Levie, W.H. (1973) Pictorial Research: an overview. *Viewpoints, 49* (2), 37-45.

Liberman, I.Y., Shankweiler, D., Fisher, F.W. and Carter, B. (1974) Reading and the awareness of linguistic segments. *Journal of Experimental Child Psychology, 18*, 201-212.

Liberman, I.Y., Shankwieler, D., Shankweiler, A.M., Fowler, C. and Fischer, F.W. (1977) Phonetic Segmentation and recoding in the beginning reader. In *Towards a Psychology of Beginning Reading*, edited by A.S. Reber and D. Scarborough. Hillsdale, N.J.: Lawrence Erlbaum.

Luellsdorf, P.A. (1984) Letter naming as a spelling strategy. In *Dyslexia: A Global Issue, NATO ASI Series D, 18*, edited by R.N. Malatesha, and H.A. Whitaker. The Hague: Martinus Nijhoff.

Luria, A. (1961) *The Role of Speech in the Regulation of Normal and Abnormal Behavior*. New York: Liveright.

Marshall, J. C. (1984) Toward a rational taxonomy of the acquired dyslexias. In *Dyslexia: A Global Issue, NATO ASI Series D, 18,* edited by R.N. Malatesha, and H.A. Whitaker. The Hague: Martinus Nijhoff.

– Toward a rational taxonomy of the developmental dyslexias. In *Dyslexia: A Global Issue, NATO ASI Series D, 18,* edited by R.N. Malatesha, and H.A. Whitaker. The Hague: Martinus Nijhoff.

Massaro, D.W. (1979) Reading and Listening (Tutorial Paper). In *Processing Visible Language, Volume 1,* edited by P.A. Kolers, W.E. Wrolstad, and H. Bouma. New York: Plenum Press.

Massaro, D.W. and Klitzke, D. (1977) Letters are functional in word identification. *Memory and Cognition, 15,* 292-298.

Meichenbaum, D. (1977) *Cognitive Behavior Modification: An Integrative Approach*. New York: Plenum.

Miller, G.A. (1956) The magical number seven, plus or minus two: Some limits on our capacity for processing information. *The Psychological Review, 63,* 81-97.

Montessori, M. (1961) *The Montessori Method*. Cambridge: MIT Press.

Nelson, T.M., Nilsson, T.H. and Frascara, J.D. (1981) Information in Letter Back grounds and Acquisition of Reading Skills, *Reading Improvement, 18 (4),* 287-294.

Newton, M. (1984) Dyslexia: A diagnostic profile for a "special educational need." In *Dyslexia: A Global Issue, NATO ASI Series D, 18,* edited by R.N. Malatesha, and H.A. Whitaker. The Hague: Martinus Nijhoff.

Olson, R., Wise, B., Connors, F., Rack, J. and Fulker, D. (1989) Specific Deficits in Component Reading and Language Skills: Genetic and Environmental Influences. *Journal of Learning Disabilities,* 22(6), 339-348.

Ozier, M. (1982) Brain behavior relationship: the alphabet as a key to memory. In *Neuropsychology and Cognition, Volume II,* edited by R.N. Malatesha and L.C. Hartlage. The Hague: Martinus Nijhoff.

Perfetti, C.A. and Lesgold, A.M. (1977) Coding and comprehension in skilled reading and implications for reading instruction. In *Theory and Practice in Early Reading,* edited by L.B. Resnick and P. Weaver. Hillsdale, N.J.: Lawrence Erlbaum.

Piaget, J. (1954) *The Construction of Reality in the Child*. New York: Basic Books.

– (1962) *Language and Thought of the Child.* New York: World Publishing.

– (1963) *The Origins of Intelligence in Children*. New York: W.W. Norton.

– (1973) *Memory and Intelligence.* New York: Basic Books.

Piaget, J. and Inhelder, B. (1956) *The Child's Conception of Space.* London: Routledge & Kegan Paul.

Pirozzolo, F.J. and Breiger, D. (1984) Neuropsychological perspectives on reading and developmental reading disability. In *Dyslexia: A Global Issue, NATO ASI Series D, 18,* edited by R.N. Malatesha, and H.A. Whitaker. The Hague: Martinus Nijhoff.

Pitman, J. (1964) *i/t/a.* Toronto: Society of Typographic Designers of Canada Format 1, 6-9.

Pollatsek, A. and Carr, T.H. (1979) Rule-Governed and Wholistic Encoding Processes in Word Perception. In *Processing Visible Language, Volume 1,*

edited by P.A. Kolers, W.E. Wrolstad, and H. Bouma. New York: Plenum.

Porter, A.W. (1974) Shape and Form. Worchester, Massachusetts: Davis.

Poteet, J.A. (1980) Informal assessment of written expression. *Learning Disability Quarterly*, *3*(4), 88-89.

Reich, S.S. and Cherry, C. (1979) A Direct Access from Graphics to Meaning. In *Processing Visible Language, Volume 1*, edited by P.A. Kolers, W.E. Wrolstad, and H. Bouma. New York: Plenum.

Rosen, C.L. (1966) An experimental study of visual perceptual training and reading achievement in first grade. *Perceptual and Motor Skills*, *22*, 979-986.

Rosner, J. (1975) *Helping Children Overcome Learning Difficulties*. New York: Walker.

Roth Smith, Corrinne (1983) *Learning Disabilities: The Interaction of Learner, Task and Setting*. Toronto: Little Brown & Company.

Rudnick, M., Sterritt, G.M. and Flax, M. (1967) Auditory and visual rhythm perception and reading ability. *Child Development*, *38*, 581-587.

Sabatino, D.H. and Hayden, D.L. (1970) Prescriptive teaching in a summer learning disabilities program. *Journal of Learning Disabilities*, *3*, 220-227.

Shankweiler, D. and Liberman, I.Y. (1976) Exploring the relations between reading and speech. In *The Neuropsychology of Learning Disorders: Theoretical Approaches*, edited by R.M. Knights and D.J. Bakker. Baltimore: University Park Press.

– (1972) Misreading: a search for causes. In *Language by Ear and by Eye: the Relationship Between Speech and Reading*, edited by J.F. Kavanagh and I.G. Mattingly. Cambridge: MIT Press.

Sheingold, K. and Shapiro, J. (1976) Children's verbal rehearsal in a free-recall task. *Developmental Psychology*, *12*, 169-170.

Sheppard, M.J. and Gelzheiser, L.M. (1984) Instructing learning disabled children to make continued and general use of a strategy for memorizing infor-mation. In *Dyslexia: A Global Issue, NATO ASI Series D, 18*, edited by R.N. Malatesha, and H.A. Whitaker. The Hague: Martinus Nijhoff.

Shindler, L. (1971) *The Effects of the Frostig Program for the Development of Visual Perception on Reading Readiness and Reading Achievement*. Albany: State University of New York Press.

Siegel, L.S. and Linder, B.A. (1984) Short-term memory processes in children with reading and arithmetic learning disabilities. *Developmental Psychology*, *20*, 20-207.

Simion, F. and Benelli, B. (1984) Differences in levels of processing related to age. In *Dyslexia: A Global Issue, NATO ASI Series D, 18*, edited by R.N. Malatesha, and H.A. Whitaker. The Hague: Martinus Nijhoff.

Singer, H. (1970) *Theoretical Models and Processes of Reading*. Newark, Delaware: International Reading Association.

Spencer, H. (1968) *The visible word*. New York: Hastings House.

Sperry, V.B. (1974) *A Language Approach to Learning Disabilities*, Palo Alto: Consulting Psychologists Press.

Spring, C. and Capps, C. (1974) Encoding speed, rehearsal, and probed recall in dyslexic boys. *Journal of Educational Psychology*, *66*, 780-786.

Standing, L. (1973) "Learning 10,000 pictures," *Quarterly Journal of Educational Psychology*, 25, 207-222.

Stewig, J.W. (1975) Assessing visual elements preferred in pictures by young children. *Reading Improvement*, *12*, 94-97.

Swartz, S. (1984) *Measuring Reading Competence*. New York: Plenum Press.

Tabor, J.I., Glaser, K. and Shaefer, H.R. (1965) *Learning and Programmed Instruction*. Reading, Massachusetts: Addison Wesley.

Taylor, Insup and Taylor, M.M. (1983) *The Psychology of Reading*. New York: Academic Press.

Tinker, M.A. (1963) *Legibility of Print*. Ames: Iowa State University.

Torgesen, J.K. (1980) Conceptual and educational implications of the use of efficient task strategies by learning disabled children. *Journal of Learning Disabilities, 13*, 364-371.

Torgesen, J.K. and Houck, D.G. (1980) Processing deficiencies of learning-disabled children who perform poorly on the digit span test. *Journal of Educational Psychology, 72*, 141-160.

Torgesen, J.K., Murphy, H.A. and Ivey, C. (1979) The influence of an orienting task on the memory performance of children with reading problems. *Journal of Learning Disabilities, 12*, 396-401.

Townsend, J.T. (1971) Alphabetic confusion: A test of models for individuals, *Perception and Psychophysics, 9*, 40-50.

Umilta, C. (1984) Hemispheric special-iza-tion and dual coding of alphabet. In *Dyslexia: A Global Issue, NATO ASI Series D, 18,* edited by R.N. Malatesha, and H.A. Whitaker. The Hague: Martinus Nijhoff.

U.S. Office of Education (1968) *First Annual Report, National Advisory Committee on Handicapped Children*. Washington, D.C.: U.S. Department of Health, Education and Welfare.

Valett, R.E. (1980) *Dyslexia: A Neuropsychological Approach to Educating Children with Severe Reading Disorders.* Belmont, California: Pitman Learning Incorporated.

– (1980) *The Dyslexia Screening Survey: A Checklist of Basic Neuropsychological Skills.* Belmont, California: Pitman Learning Incorporated.

Vellutino, F.R. (1987) Dyslexia, *Scientific American. 256*(3), 34-41.

Vellutino, F.R., Harding, C.J., Phillips, F. and Steger, J.A. (1975) Differential Transfer in Poor and Normal Readers. *The Journal of Genetic Psychology, 126,* 3-18.

Vellutino, F.R., Pruzek, R.M., Steger, J.A. and Meshoulam, U. (1973) Immediate Visual recall in poor and normal readers as a function of orthographic-linguistic familiarity. *CORTEX, 4*, 368-384.

Vellutino, F.R., Smith, H., Steger, J.A. and Kaman, M. (1975) Reading disability: age differences and the perceptual deficit hypothesis. *Child Development, 46*, 487-493.

Vellutino, F.R., Steger, J.A., DeSotto, L. and Phillips, F. (1975) Immediate and Delayed Recognition of Visual Stimuli an Poor and Normal Readers. *Journal of Experimental Psychology, 19* (2), 223-232.

Vellutino, F.R., Steger, J.A., Kaman, M. and DeSotto, L. (1975) Visual form perception in deficient and normal readers as a function of age and orthographic-linguistic familiarity. *CORTEX, 4*, 22-30.

Vellutino, F.R., Steger, B.M., Moyer, S.C., Harding, C.J. and Niles, J.A. (1977) Has the Perceptual Deficit Hypothesis Led Us Astray? *Journal of Learning Disabilities, 10*(6), 1-12.

Venezky, R.L. (1979) Orthographic Regularities in English Words. In *Processing Visible Language, Volume 1,* edited by P.A. Kolers, W.E. Wrolstad, and H. Bouma. New York: Plenum.

Vernon, M., Coley, J. and DeBois, J. (1980) Using sign language to remediate severe reading problems. *Journal of Learning Disabilities, 13,* 215-218.

Wallis Burke, P. (1975) The myth of the 26 letter roman alphabet. *Edugraphic/ Icographic, 9,* 4-15.

Whitshaw, I.Q. and Kolb, B. (1984) Neuropsychological assessment of children and adults with developmental dyslexia. In *Dyslexia: A Global Issue, NATO ASI Series D, 18,* edited by R.N. Malatesha, and H.A. Whitaker. The Hague: Martinus Nijhoff.

Wiig, E.H. and Semel, E.M. (1980) *Language Assessment and Intervention for the Learning Disabled.* Columbus, Ohio: Charles E. Merrill.

Wise, B., Olson, R., Anstett, R.M., Andrews, L., Terjak, M., Schneider, V., Kostuch, J. and Kriho, L. (1989) Implementing a long-term computerized remedial reading program with synthetic speech feed-back: Hardware, software and real-world issues. *Behavior Research Methods, Instruments, and Computers, 21*(2), 173-180.

Woodcock, R.W. and Clarke, C.R. (1969) *Peabody Rebus Reading Program.* Circle Pines, Minnesota: American Guidance Service.

Zigmond, N., Vallecorsa, A. and Leinhardt, G. (1982) Reading instruction for students with learning disabilities. In *Language Disorders and Learning Disabilities,* edited by K.B. Butler and G.P. Wallach. Rockville, Maryland: Aspen.